COMMISSION OF CONSERVATION
CANADA

WATER-POWERS OF CANADA

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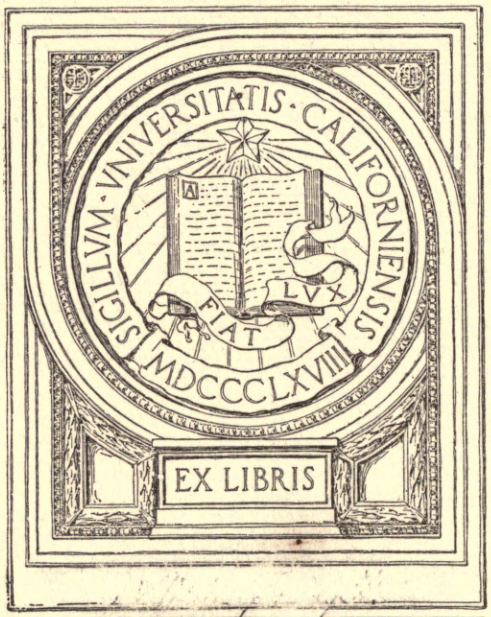

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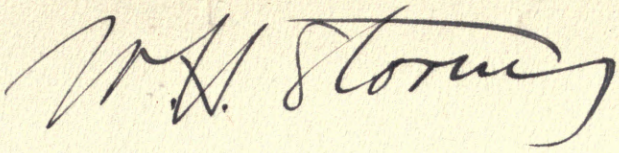

Commission of Conservation
Canada

HONOURABLE CLIFFORD SIFTON, Chairman
JAMES WHITE, Secretary

Water-Powers of Canada

BY
LEO G. DENIS, B. Sc., E. E.
AND
ARTHUR V. WHITE, C. E

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To His Excellency, the Right Honourable Sir Albert Henry George, Earl Grey, G.C.M.G., etc., etc., Governor General of Canada

May It Please Your Excellency:

The undersigned has the honour to lay before Your Excellency the report of the Commission of Conservation on the "Water-Powers of Canada."

Respectfully submitted

CLIFFORD SIFTON

Chairman

Ottawa, Sept. 22, 1911

OTTAWA, Sept. 23, 1911

Sir:

I have the honour to transmit herewith a report on "The Water-Powers of Canada," the result of nearly two years' work of investigation and compilation on the part of the officials of the Commission of Conservation. The chapters dealing with the water-powers of Quebec, Manitoba, Saskatchewan, Alberta and the Northwest Territories are the work of Leo G. Denis, B.Sc., Hydro-Electric Engineer of the Commission of Conservation. The greater part of the report was written by Arthur V. White, C.E., who has had considerable experience in work of this kind under the Hydro-Electric Power Commission of Ontario. Mr. White is the author of the introductory portion of the work (Chapters I and II) and of the chapters on the waters of Ontario, Nova Scotia, Prince Edward Island and New Brunswick. He also compiled the Bibliography and selected the material appearing in the Appendices. The chapter respecting the water-powers of British Columbia was written by W. J. Dick, M.Sc., Mining Engineer of the Commission of Conservation. Chapter IX on "Irrigation in Western Canada" was kindly contributed by George B. Hull, C.E.

The information respecting the water-powers of Ontario, Quebec, Nova Scotia, New Brunswick and Prince Edward Island is much more complete than that of the other provinces. In regard to Quebec, much information has been obtained from the reports of Messrs. Gauvin and Langelier, made to the Department of Lands and Forests, Quebec, and from the Georgian Bay Ship Canal survey—most of the powers in the portion of the Ottawa river covered by the latter being owned, partly, by Quebec and, partly, by Ontario. In the summer of 1910, Mr. Leo G. Denis was occupied in supplementing and verifying existing data. In the case of Ontario, extensive use has been made of the very valuable reports of the Hydro-Electric Power Commission and, as in the case of Quebec powers, of the Georgian Bay Ship Canal survey. For the Maritime Provinces, the available information was so meagre that the Commission deemed it advisable to conduct field operations under Mr. Arthur V. White during the summer and autumn of 1910. The information available concerning Manitoba, Saskatchewan, Alberta, and British Columbia was found to be so scanty that the Commission has found it necessary to institute a reconnaisance survey of the powers in those provinces. The work in the Prairie provinces is being carried out by Mr. Denis and the British Columbia surveys are under the direction of Mr. A. V. White. The results of these investigations will be published later as a report on the "Water-Powers of Western Canada."

On the whole, it may be said that the report is the most complete work of its kind that has been published on the water-powers of the Dominion; for, not only does it embody the essential features of information previously known, but it also supplements these by the results of field surveys conducted by the Commission in several provinces. In addition the published and unpublished information respecting these powers has, for the first time been brought together. The data respecting the legislation, public and private, connected with the great hydro-electric plants at Niagara Falls, has never been compiled before nor, is there extant any other history of he movements that led up to the formation, in its present form of the Hydro-Electric Commission of Ontario.

The Commission wishes to acknowledge its obligation to those who generously assisted in the compilation of this report by supplying information in their possession. Among those from whom valuable information was obtained are the following:—Federal Department of Public Works, Hydro-Electric Power Commission of Ontario, International River St. John Commission, Federal Department of Railways and Canals, Queen Victoria Niagara Falls Park Commissioners and other departments and officials of the Dominion and Provincial Governments; the engineering profession throughout Canada; the officials of the Canadian Pacific, Grand Trunk Pacific, Canadian Northern and other railways; and the various power companies that furnished information concerning their properties.

I have the honour to be,
Sir,
Your obedient servant

JAMES WHITE,
Secretary

HON. CLIFFORD SIFTON
Chairman, Commission of Conservation
Ottawa

CONTENTS

Chapter		Page
I.	General Introduction	1
II.	Water-Power Data	12
III.	Water-Powers of Ontario	23
IV.	Water-Powers of Quebec	150
V.	Water-Powers of Nova Scotia	195
VI.	Inland Waters of Prince Edward Island	228
VII.	Water-Powers of New Brunswick	230
VIII.	Water-Powers of Manitoba, Saskatchewan, Alberta, Yukon and North West Territories	275
	I. Manitoba	283
	II. Saskatchewan and Alberta	285
	III. Yukon	288
IX.	Irrigation in Western Canada	295
X.	Water-Powers of British Columbia	303
	Appendices:	
	Boundary Waters Treaty of 1909	331
	Bed of Navigable Waters Act, Ontario	340
	Electricity and Fluid Exportation Act, Canada	341
	Regulations under the Electricity and Fluid Exportation Act	344
	Form of License to Export Power, Canada	346
	Bibliography	347

ILLUSTRATIONS

PAGE

Horseshoe Fall, Niagara ..... *Frontispiece*

"The Notch," Montreal River, Ontario 16

Kakabeka Fall, Kaministikwia River, Ontario 23

Virgin Fall, Nipigon River, Ontario 33

Chaudière Regulating Dam, Ottawa River, Ottawa 40

Hydro-Electric Transmission Line "A," showing Joint in Tower Loop 48

Transmission Lines, Southwestern, Ontario, *Map* 50

Dam No. 1, Trent Canal, Hastings Co., Ontario 54

Map of Niagara Falls, showing location of Power Developments 64

Cross-sectional View of Plant of The Canadian Niagara Power Company at Niagara Falls 72

Cross-sectional View of Plant of The Ontario Power Company at Niagara Falls 75

Cross-sectional View of Power House of The Electrical Development Company at Niagara Falls 80

Aubrey Fall, Mississagi River, Ontario 96

Sixth Fall, White River, Ontario 96

Transmission Lines, N.E. and N.W. Ontario, *Map* 100

Couchiching Fall, Abitibi River, Ontario 104

Gajigamok Fall, English River, Ontario 104

Upper Ottawa Storage:

- Basin of the Ottawa River, *Diagram* 138
- Approximate Discharge of Ottawa River, *Diagram* 138
- Water Surface Profile, Kipawa River, *Diagram* 138
- " " River des Quinze, *Diagram* 138
- " " Ottawa River, *Diagram* 138
- " " Gordon Creek, *Diagram* 138
- " " Petawawa River, *Diagram* 138
- " " Madawaska River, *Diagram* 138
- Daily Discharge of the Gatineau River, *Diagram* 138
- Water Surface Profile, Gatineau River, *Diagram* 138
- " " Rideau River, *Diagram* 138
- " " Du Lièvre River, *Diagram* 138
- " " Rouge River, *Diagram* 138

Ouiatchuan Falls, Lake St. John, Quebec 150

Shawinigan Falls, St. Maurice, Quebec 153

Transmission Lines in Quebec and New Brunswick 154

Dam on Chaudière River, near Lévis, Quebec 156

Laurentide Paper Company's Plant, Grand'mère, Quebec 158

Chicoutimi Fall, Chicoutimi River, Quebec 160

Métis Falls, Métis River, Matane, Quebec 162

Montmorency Falls, Montmorency River, Quebec 165

Freshet, Upper Pulp Mill Dam, Liverpool River, Nova Scotia 195

Liverpool River at Low Water, Showing Boulder Strewn Bed 198

Average Monthly Precipitation in Inches for 37 Years at Halifax, Nova Scotia, *Diagram* 200

ILLUSTRATIONS

	PAGE
Annual Precipitation in Inches at Halifax, Nova Scotia, *Diagram*	200
Drainage Basin of East river Sheet Harbour, *Map*	201
Shelburne Municipal Hydro-Electric Plant on the Medway River, Nova Scotia	202
A Mine Power House at Isaac Harbour, which Utilizes Small Watershed with High Head	202
A Typical Log-driving Dam, Nova Scotia.—Note the Dead Trees, the Result of Flooded Banks	202
A Difficult Problem in Fish-ways, Pulp-mill Dam, Sissibou River, Nova Scotia	202
Saw-mill on St. Croix River, Nova Scotia, run by Water-power the Year Round	204
Suitable for Power-site Dam, Ecumsecum River, Nova Scotia	204
Hydro-Electric Development, Montague River, Prince Edward Island	228
Grand Falls, St. John River, New Brunswick	230
Magaguadavic River, New Brunswick, Water-driven Pulp Mill, etc	232
Power House near Mouth of Aroostook River, New Brunswick	232
Looking down Tobique River, New Brunswick	232
First Falls, Head of Tide, Musquash River, New Brunswick	232
Discharge of St. John River at Grand Falls, New Brunswick, *Diagram*	237
Tetagouche River, New Brunswick, from Bluff Overlooking Tetagouche Falls	240
Grand Falls, Nipisguit River, New Brunswick	240
Curves Indicating the Discharge of the Upper St. John River and its Tributaries, New Brunswick, *Diagram*	242
City of Winnipeg Power Plant, Point du Bois, Winnipeg River, Manitoba	277
Transmission Lines in Western Canada, *Map*	283
Horseshoe Falls, near Kananaskis, Alberta	285
Bow River Falls, Rocky Mountains Park, Banff, Alberta	286
Kananaskis Falls, Kananaskis, Alberta	286
White Horse Rapids, Lewes River, Yukon	288
Hydraulicing in American Gulch, Yukon	288
Main Canal, C.P.R. Irrigation Block, Alberta	295
Main Canal, Eastern Section, C.P.R. Irrigation Block	300
Bassano Dam, Bow River, Eastern Section, C.P.R. Irrigation Block	300
Stave Falls, British Columbia	303
Stave Falls, British Columbia—Another view	304
Opening of Vancouver Power Company's Tunnel Connecting Coquitlam Lake with Buntzen Lake, British Columbia	306
Power House, North Arm, Burrard Inlet, British Columbia	306

HORSESHOE FALL, NIAGARA FALLS, ONT.

The Water-Powers of Canada

CHAPTER I

General Introduction

WATER-POWER development is one of the important uses to which many of our inland waters may be applied. But the importance of this one use must not be allowed to blind us to the fact that there are other uses that are equally important. Too often it has been the tendency in reports on water-power resources to consider power development exclusively, without giving adequate place in them to such related subjects as navigation, agriculture, and domestic water-supply. Practically all our fresh water comes primarily from one source—precipitation; and in every instance of proposed water-power development, it is incumbent upon us to determine whether there will be any prejudicial effect upon these other related interests, which depend upon the same source of supply and which have a claim upon our fresh waters, both surface and underground.

In this report, the necessity of treating the subject of power development in a broad-minded way with due consideration for the other uses for which water may be required, has been dwelt upon. The report includes a comprehensive examination into the general character and extent of the existent published data relating to the water-powers of Canada. The need for more complete data than now exists has been emphasized and the qualities desirable water-power data should possess have also been indicated.

Speaking generally, it may be said that no public records exist which adequately set forth the amounts, locations and characteristics of the water-powers of the Dominion. There are instances where private or corporate interests have had individual water-powers developed, surveyed and otherwise more or less thoroughly examined; and instances, also, where daily gaugings of water levels are taken with the object of determining the regimen of the waters contributory to some particular source of water-power; but such instances where data are carefully collected are the rare exception and not the general rule.

A full consideration of water as a natural resource directs attention to so many interests that are primarily dependent upon it, that it becomes imperative to exercise keen discrimination in determining what weight

and importance shall be attached to the water-power data we have to consider. Therefore, before passing to the treatment of more specific subjects, it will be profitable to offer some remarks which are pertinent to water when viewed broadly as a natural resource. These remarks will suggest what demands data relating to water-powers in particular should be expected to meet. Special phases of the subject will be illustrated by concrete examples taken from particular reports. These illustrations will also emphasize more specifically just why it is necessary to have much fuller data than exist at the present time respecting the water-powers of Canada.

Importance of Water-Powers May be Exaggerated

There has been a tendency on the part of many persons interested in the conservation of natural resources to state that this or that particular resource is the most important. Some have said that the forests are the most important asset; others maintain that the soil, with its fertility, is the most important resource; and, of late, great stress is being laid upon the statement that water is the chief asset, the prediction being made that the nation which has the most and cheapest water-power available is destined to take precedence in the world of commerce. As a matter of fact, however, all these various interests are interdependent one upon the other. If any one feature of our natural resources is to be placed before others, probably it could be most reasonably urged that a fertile condition of the soil is the most important natural asset to be safeguarded; because, for his sustenance on the earth, man requires food, raiment, and shelter, and these essentials are supplied him, in one form or another, either directly or indirectly, from the soil. It must be manifest, therefore, that the factors which make for the permanence of the soil's productivity are factors of paramount importance; and hence the subject of the conservation and use of waters as a natural asset must, among other things, be considered in its prime relationship to the subject of the productivity of the soil.

It may assist to a better understanding of some of the statements made herein if the fact is borne in mind that the greatest danger which besets the natural resources of not only this country, but of the world, is the undue disturbance of the balance which Nature seeks to maintain. Hence, in presenting the data which follow, no special effort has been made to attach an importance to water-power, *per se*, to which it is not entitled.

Interdependence of Interests

The interests of municipal and domestic water supply, water for manufacturing and industrial purposes, irrigation, navigation, and water-power, are all inter-related and interdependent. They all depend on the same natural source—precipitation. Precipitation by rainfall or snowfall virtually constitutes the only source of inland water supply, and the natural and cultivated properties of the

land on which the rain and snow fall, largely determine the efficient uses to which precipitation is applied. It is in this connection that forests are so indispensably associated with the rainfall, and hence, with water as a natural resource. Whatever opinion may be entertained as to the effect of forests in influencing the amount of precipitation, all are agreed that no feature of the topography of a country ministers more efficiently to the gradual and economical run-off from the precipitation than do forest areas. Thus it is that failure to intelligently conserve forest areas has wrought havoc by causing a great destruction of forest floors and agricultural lands, which, humanly speaking, can never be restored, to say nothing of the annual destruction to property by flood run-off, which seems yearly to increase rather than diminish.*

In the case of water-power developments, therefore, it is necessary to know whether, or not, the industries which propose to use the water-powers will prove to be a menace to the district of their proposed location. Thus, wood-pulp mills, for example, which might completely denude the timber lands of trees, at, or near, the head waters of important waterways had better not be established at all; or if established, then only under the strictest regulation and supervision designed to conserve the forest growth. A deforested, eroded, and scoured territory, which has lost the humus of its soil, cannot retain the beneficent rains which, instead of being retained in the ground and transmuted into plants by the various processes of growth, carry destruction in the pathways of their torrential run-off. The water is necessary to the soil, and the soil, with its plant growth, is necessary to an economical disposition of the water.

Water-Power and Agriculture

Consider, next, a little more in detail, the possible effects which the diversion of water for power or other purposes may have on agriculture. Of the annual rainfall upon the earth, about one-half is evaporated; about one-third is "run-off"—that is, it runs off over or through the ground, and eventually reaches the sea; and about one-sixth either joins the ground-water, or is taken up into plant structure or is otherwise absorbed in processes incident to the ground. Underneath the surface of the earth is a vast body of water which may be likened to an underground lake, called *the ground-water.* It is into the upper surface, frequently termed *the water-table,* of this ground-

* According to the *National Conservation Commission Bulletin* No. 4, Washington, D.C., 1909, p. 17, "The direct yearly damage by floods since 1900, has increased steadily from $45,000,000 to over $238,000,000." 'Flood run-off is the most transient, irregular, wasteful and dangerous part of precipitation. Its damage in the United States in 8 months, from Jan. 1st to Aug. 31st, 1908, was $237,000,000; washing away buildings, goods, bridges, roads, real estate and railroads. The net loss just mentioned does not include the deterioration of values not actually destroyed, nor financial loss dependent upon the lessened morale of the people.' See Mr. Bailey Willis, in *Conservation,* No. 5, Washington, 1909, p. 274.

water that wells are sunk for domestic and other water supply. It has been estimated that, if all the moisture resident in the upper 100 feet of the ground were collected, the amount would be the equivalent of a lake of water some 17 feet deep, *i.e.*, the equivalent of about 7 years' rainfall. During periods of plant growth, this ground-water yields, chiefly by capillary action, part of its moisture to the plants; and then, during seasons of excessive rainfall, is again replenished from the rainfall. The annual fluctuation in level of the ground water-table under normal conditions is but a few inches. Such states as Minnesota, Iowa, Wisconsin, Southern Michigan and the Dakotas, have already experienced alarming and permanent recedence in the levels of their ground-waters, and a consequent diminution in crop production. Large sums of money have been expended by the Federal and State Governments in the United States, on the investigation of the occurrence and flow of underground water, and it is now being recognized more and more that proposed disposition of the run-off, and underground waters, should be considered together, because of a natural balance that exists between them.*

It is easily possible to so divert some watercourses as to allow much of the ground-water to be lost, and, consequently, cause permanent damage to a large expanse of territory. Great waste and carelessness have been manifested in many localities by the users of the underground waters. In the smaller towns, where the domestic wells furnish the water supply, it has frequently been observed that, when some deep trench, as, for example, a cut for a new sewer or a mine shaft, has been excavated, the underground waters have drained away, thus "bleeding" the adjacent territory and causing the wells of the neighbourhood to go dry. The lessons that may be drawn from such illustrations should not be forgotten in considering our valuable underground waters, when viewed provincially or with respect to their larger areas.

The underground waters of Canada, in some places, are now being tapped and wasted. State after state, in the United States, has enacted laws designed to conserve the underground waters. A main feature of such laws has been the regulation of the flow by specifying the size of the pipe through which ordinary domestic and farm water supply may be taken. Sometimes the law states that the supply shall be taken through a pipe one-half of one inch in diameter which shall be furnished with a stop

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* Regarding the general subject of Underground Waters, consult the following Water Supply and Irrigation Papers of the U. S. Geological Survey. *Underground Waters of Eastern United States*, 1905, *No.* 114; *Bibliographic Review and Index of Papers relating to Underground Waters*, 1879–1904; 1905, No. 120; *Relation of the Law to Underground Waters*, 1905, No. 122; *Field Measurements of the Rate of Movement of Underground Waters*, 1905, No. 140; *Underground Water Papers*, 1906, No. 160; *Bibliographic Review and Index of Underground Water Literature published in United States in* 1905, No. 163.

valve. In some states the penalties for violation of the law relating to underground waters are severe; for example, in the state of South Dakota

> "If any person complains that the proprietor of an artesian well, or the party controlling such well, is in the habit of letting the waters go to waste, the Township Supervisor, County Commissioner, Road Overseer, Alderman, or other City Officers, may enter upon the premises where the well is located in order to determine whether the complaint is justified, and may institute criminal prosecution in case violation of the law is ascertained. If the well is without valves to regulate the flow and prevent waste, the person owning the well may be fined up to one hundred dollars, or be imprisoned not more than three months in jail, or both."*

Laws regulating the use of underground waters are needed in the province of Ontario and in other provinces of Canada. At the present time in Southern Ontario, farmers and others are tapping these underground waters and, in some cases where "gushers" have been struck, the valuable waters are permitted to run to waste continuously.

The following statement relating to the underground waters of Southern California is instructive. Discussing this subject at the Second Conference of the Engineers of the United States Reclamation Service, F. C. Finkle said:

> "Much investigation has been carried on to determine the extent of the underground water supplies in Southern California. All investigators have reached about the same conclusion, that the supply produced by nature, annually, for the replenishment of these reservoirs is limited. While it is considerable in years of abundant rainfall, it becomes almost nothing in years of minimum precipitation, and a mean must be drawn so that the reserve supply is not withdrawn to such an extent as to imperil this resource. Up to the present time this has been much neglected, and the haphazard and reckless way in which promoters have attacked the underground water supply of Southern California has demonstrated the necessity of future retrenchment. A great number of cases may be cited where one company has obtained a supply of water by underground development, soon to find that someone else would follow them and either take away a portion or all of their supply. Cases of this kind became so numerous that the matter had to be brought to the attention of the Courts and much expensive litigation has been the result."†

Of this ground water, Dr. W. J. McGee, Secretary of the United States Inland Waterways Commission, states:

> "It is the essential basis of agriculture and most other industries, and the chief natural resource of the country; it sustains forests and

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* Johnson, D. W., *Relation of the Law to Underground Waters*, Washington, 1905; p. 47. (W. S. & Irr. Paper No. 122).

† Newell, F. H., *Proceedings of Second Conference of Engineers of the Reclamation Service*, Washington, 1905; p. 59. (W. S. & Irr. Paper No. 146).

all other crops and supplies the perennial streams and springs and wells used by four-fifths of our population and nearly all of our domestic animals. Its quantity is diminished by the increased run-off due to deforestation and injudicious farming. Throughout the upland portions of the Eastern United States, the average water-table has been lowered ten to forty feet, so that fully three-fourths of the springs and shallower wells have failed, and many brooks have run dry, while the risk of crop loss by drought has proportionately increased, and the waste through the Mississippi has increased over fifteen per cent."*

In the face of such facts it will be realized that it would be imprudent to ignore the claims which the ground-water supply has upon its proportion of the rainfall. Certainly, watercourses and the sources of their supply should not be so disturbed in, or by, the development of water-power, or other water interests, as to cause a permanent depletion, or pollution, of the underground waters. Upon this point, therefore, it is necessary that the amounts, movements, and functions of the ground-water in any district be studied in connection with any general scheme devised for the utilization of the water for power, or other purposes, in that particular territory.

Water-Power and Navigation

Next consider the mutual relationship which may exist between navigation and power, when dependent upon some waters common to both interests. It is very difficult to draw the line where natural features cease to affect navigation. Forests, for instance, exert a tremendous influence on the navigability of both lakes and rivers. Although none of the various forest streams may be navigable as they issue from the forest, yet each exerts its measure of influence in contributing to the general flowage of some main navigable waterway. The importance which some authorities attach to the conservation of water, to the end that it may serve the interests of navigation prior to those of power, is well illustrated from a statement made in connection with the policy of the International Waterways Commission. The Report of that Commission says on this point:

"The joint commission had agreed, as one of the principles which should govern the use of boundary waters, that, where there could be temporary diversions without injury to the interests of navigation for the purpose of developing power, they should be allowed,..... The paramount right to use the great water system, starting with lake Superior and finding its way by the St. Lawrence to the Sea, is for navigation purposes; but as temporary diversions are possible at Sault Ste. Marie, on the Niagara river, on the St. Lawrence river and elsewhere, without injury to the interests of navigation, it is, of course, desirable that they should be permitted."†

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* McGee, W. J., *Water as a Resource*, in the *Annals of the American Academy of Political and Social Science, May*, 1909; p. 46–47.

† *International Waterways Commission, Supplementary Report*, 1907, (*Ottawa*, 1908), p. 12. See, also, Chairman's remarks, *Ibid.*, p. 21.

Again is this illustrated in the United States Federal Act of March 3rd, 1909 (Public Acts, No. 317), respecting the water rights of the St. Mary river. Referring to this International waterway bordering the state of Michigan, the Act states that these waters

> "shall be forever conserved for the benefit of the Government of the United States, primarily for the purposes of navigation, and, incidentally, for the purpose of having the water-power developed, either for the direct use of the United States, or by lease or other agreement through the Secretary of War.....Provided that a just and reasonable compensation shall be paid for the use of all waters or water-power now or hereafter owned."

The International Boundary Waters Treaty between Great Britain and the United States, as ratified in the year 1909, under Article VIII, gives "the rules or principles" which shall govern the International Joint Commission in determining the order of precedence which shall be observed in the disposition of water privileges. Article VIII states that

> "The following order of procedure shall be observed among the various uses enumerated hereinafter for these waters, and no use shall be permitted which tends materially to conflict with or restrain any other use which is given preference over it in this order of precedence:
>
> (1) Uses for domestic or sanitary purposes.
> (2) Uses for navigation, including the service of canals for the purposes of navigation.
> (3) Uses for power and for irrigation purposes."

From the foregoing statements, it is evident that the very valuable power possibilities on such waters as the St. Mary, the Niagara or St. Lawrence rivers are regarded as of less, or as of only "incidental," value as compared with the primary interests of navigation.

A particular instance may now be cited to impress the fact that power development is not always to be given precedence over other interests. Incidentally, this illustration will serve to show the uncertainty of water-power prospects predicted by estimates based on meagre data.

As is well known, the navigation interests on the Muskoka lakes are important. These lakes discharge their flow over Bala falls on the west side of Muskoka lake. The waters from Bala falls proceed by the Muskoka river to the Moon chute, and thence, by two branches, to Georgian bay.

The low-water flow for Bala falls has been estimated at 840 cubic feet per second, corresponding to 1,530 horse-power. During the summer and fall of the year 1908, all the stop-logs were in the dam at Bala falls and, in addition, vertical sheathing was placed on the upstream side of the stop-logs to reduce the leakage through the dams. An endeavour was made to have as little water as possible escape at the falls to the Muskoka river. This condition was maintained for many weeks, but, in spite of

the measures taken, it was not found practicable to preserve the water level desired for the purposes of navigation in the Muskoka lakes and, at times, barely sufficient water was obtainable to permit boats to pass the locks at Port Carling. During this period, therefore, instead of a low-water flow of 840 cubic feet per second, as estimated, the actual flow at low water, neglecting leakage, would be *nil*; and, hence, during such a period, no power whatever would be available.

Formerly, in the interests of navigation, the Ontario Government endeavoured to keep the water at 8 ft. 4 in. on the gauge at Bala, but, in 1908, owing to the increased importance of this station, an effort was made to hold the gauge at 8 ft. 6 in. A reference to the table of readings for the seven months from June to December, 1908, will show how far short the water supply fell from giving the desired level. Indeed, for some weeks, the level was as low as 7 ft. 9 in.

It might hastily be stated that the Muskoka waters could be stored to maintain the estimated low-water flow, but it is questionable to what extent the pondage possibilities of these lakes could be advantageously used to store water and aid in the maintenance of the minimum flow of 840 cubic feet per second before mentioned. If the gauge at Bala were kept at the desired level, viz., 8 ft. 6 in., a rise of 2 ft. above this point would be the probable outside limit to which storage could be contemplated in lake Muskoka, without very seriously flooding dwellings and boat-houses, together with other improved and unimproved property on the shores of this lake. In the other lakes, a corresponding rise of say 2 feet would also be the greatest that could reasonably be considered. The area of the Muskoka lakes (Muskoka, Joseph and Rosseau) is about 100 square miles. If these lakes be used as a reservoir in which the water level is raised two feet above the desired gauge level at Bala, the stored waters would suffice for a flowage of 840 cubic feet per second, for a period of 80 days, or, for only about 75 per cent. of the time during which the low water prevailed in the season of 1908.

But, if it became necessary, in the interests of navigation alone to make storage provisions, a considerable proportion of the storage capacity of the Muskoka lakes would be required during seasons of low water to bring the water from such a level as 7 ft. 9 in., as existed during quite a portion of the fall of 1908, up to the desired level of 8 ft. 4 in., or thereabouts. This computation takes no account of additional storage that might be furnished by the lakes in the Lake of Bays district, but if the levels of lake Vernon, Mary and Fairy lakes and lake of Bays were raised 2 ft., it would maintain a flowage of 840 cubic feet per second through the Muskoka lakes for about 40 days. The subjects of navigation and storage would therefore have to be specially considered in making estimates of the power possibilities of the Muskoka river. It must not be forgotten that the continued deforestation of the Muskoka district and

the devastation wrought by forest fires are factors which very materially reduce the uniformity of the annual run-off; so that low-water conditions as affecting navigation, may become more and more serious, and call for the utilization of the storage capacities of the lakes on behalf of navigation alone.

A condition of affairs such as is mentioned regarding an absence of flow through the Bala falls would obviously also affect all the water-powers between Bala and Georgian bay. Thus, instead of having over 7,000 H.P., as estimated as a minimum 24-hour horse-power for the Moon chute and stations lower down on the river, there would be almost no power during the period that water was prevented from discharging over Bala falls.

From this illustration it may be clearly seen that the data respecting water-power possibilities on the waterways formed by the outflow from the Muskoka lakes, could not be safely used without understanding their limitations, and understanding, also, the effects which hydro-electric development might have upon other interests that already exist in these lakes. Moreover, it will also be apparent that, if the water-power possibilities of various sites were being classified, a possible 7,000 H.P. on the waters flowing from the Muskoka lakes would be in a much inferior class to a possible 7,000 H.P. on, say, the Nipigon river, where uniformity of flow for such an amount of power may readily be insured.

Pollution by Factory Wastes

The effects likely to result from the pollution of waterways by the waste products emitted from the industries utilizing power from these waterways are also very important factors for consideration. The maintenance of a pure and sufficient domestic water supply is a vital consideration; and, hence, a class of industrial waste products that will destroy life in the waters into which they are turned, must be regarded seriously in their probable influences on human life.*

* The subject of the disposal of waste in its various forms will demand in the future more serious attention because of the great and increasing pollution of waters which unfits them for necessary uses. The effects of sewage upon waters into which it has been turned may be studied through the many valuable publications and reports which treat of this subject. With regard, however, to the great destruction wrought by the waste products emitted from manufacturing plants, much less data has been published. This subject will be found well opened up after a study of such U. S. Government publications as the following. (The numbers after each title are the numbers of the individual *Water Supply and Irrigation Papers* of the U. S. Geological Survey). *Normal and Polluted Waters in North-eastern* U. S., 1903, No. 79; *Disposal of Straw-board and Oil-well Wastes*, 1905, No. 113; *Review of Laws forbidding Pollution by Distillery Refuse*, 1906, No. 179; *Stream Pollution by Acid Iron Wastes*, 1906, No. 186; *Prevention of Stream Pollution by Straw-board Waste*, 1906, No. 189; *Pollution of Streams by Sulphite Pulp Waste*, 1909, No. 226. See, also, *The Effect of some Industrial Wastes on Fishes*, by M. C. Marsh, in a report on *The Potomac River Basin*, Wash., 1907, No. 192, pp. 337-348.

It is also of the utmost importance that the percolating and underground waters be conserved against pollution. In a recent address before the Eastern Dairymen's Association, at Belleville, Ont., Dr. W. T. Connell, professor of bacteriology at Queen's University, pointed out the serious condition of many of the sources of water supply of factories and farms. In his address he said:

> "Another subject to which considerable attention has again been given is that of water supplies at factories and at farms. During the past year, over two-thirds of such samples submitted have proven to be infected with dangerous forms of bacteria. I class as dangerous, forms which can be traced as originating from the intestinal discharges of animals or man, or, in the case of factories, as coming from factory drainage. Of course, it must be remembered that I am only sent samples which have fallen under suspicion, so that my figures do not represent the average condition of the farm and factory wells in Eastern Ontario. Still, I think I can state that quite one-third of the wells at farms and factories are so situated as to be open to pollution from surface drainage or from seepage from manure piles, stables or pig-pens, or from house wastes."

What is true of pollution in local conditions may become correspondingly true over larger areas if proper regulation is not exercised over the disposal of waste where it is disposed of on a larger scale.

Guiding Principles in Classification

The amount of water-power is determined by two factors: first, the hydrostatic head, or the vertical distance through which the water may fall; and second, the amount of water which may be made to operate upon the water-wheels. There are, however, many characteristic features associated with water-powers which differentiate one power from another, and which determine the commercial and economic values of the individual powers. In presenting water-power statistics, these features should therefore be taken into consideration and possible water-powers classified accordingly. The uniformity of the flow of water greatly affects the values of water-powers situated upon the various watercourses. For example, the St. Lawrence river, owing to the vast storage capacity of the natural reservoirs found in the Great lakes, has the most uniform flow of any large river in North America or, probably, in the world. Therefore, other conditions being equal, water-power developments on this river will be of very much greater value than developments on a river subject to such great variations of flow as take place, for example, on the Mississippi. Again, water-power capable of being used, or likely to be used, for supplying the energy for municipal and community purposes, such, for example, as lighting, heating, pumping and certain kinds of manufacturing, should be classified very differently from power to be used in large manufacturing plants, the supplying of the raw material for which, as has already been suggested, may mean virtually the destruction of Nature's balance in the territory where the

plants operate. Thus, the classification of powers according to their probable uses is very different, and the basis to guide in the granting of power privileges must be a full knowledge of the governing conditions at, and in the vicinity of, the sources of the water-powers. It must not be forgotten that, in order to state in a reliable manner the power available for any place, it is necessary to give the stage of the river at which the amount of power stated may be produced.

Calculating the Available Power

The foregoing remarks have emphasized the fact that waters affording power facilities have to be viewed from other standpoints than the actual development of their powers, and should be classified accordingly. This is a consideration which has too often been neglected in reports on water-powers.

The following considerations should be kept in view in determining the water-power available under different circumstances of flow:

First.—The minimum or primary power is the amount of power that may be developed during the period of lowest flow.

Second.—As the extreme low-water conditions frequently last for a comparatively short portion of the year, it is possible to develop during the greater portion of the year, a much larger amount than the minimum power, and this larger amount is often quite suitable for a class of industry that does not require to operate its plant throughout the whole year. This may be termed the secondary power, and its amount may be many times the amount of power corresponding to the minimum flow.

Third.—If the upland portions of a watershed are supplied with reservoirs, where flood waters are conserved, the amount of power that may be developed may be very greatly augmented. Some conception of the possibilities of storage may be formed from the proportions which exist between minimum and flood flows. For example, the proportion of the flood to the minimum flow on the St. Lawrence is about 2 to 1; on the Ottawa it exceeds 15 to 1; on the Hudson river, at Mechanicville, N.Y., it is 100 to 1; and on the Delaware river, at Port Jervis, 375 to 1. Thus, in many instances, the amount of power gained by conservation of the flood waters is a very important feature to be considered

In passing, it may be noted that where an early selection of reservoir sites is made, and the same held under government control, so that no settlement, railway construction, or other "culture," is allowed to take place upon such reservoir sites, the expenses and troubles incident to future reimbursement for expropriated properties will be avoided.

CHAPTER II

Water-Power Data

ONE of the chief objects in acquiring data respecting possible water-powers is, first, to enable the owners of the rights to know the possibilities and limitations of their water-powers and thus arrive at some judgment as to their possible uses and value; and, second, to enable prospective promoters of water-power development to learn the general possibilities of various powers without the necessity of costly independent preliminary surveys. Certainly, if the Crown be the owner of water-powers, it is of the utmost importance that it be informed beforehand upon all the important facts connected with its water resources. When information regarding water-powers is to be gathered, it is extremely important that the data be sufficient, and of the class that will enable a sound opinion to be formed upon the general water interests involved.

Necessity for Reliable Data

The regulations respecting waters which are to be set aside for the development of power should be so framed as to require that the preliminary installation of dams and other main works necessary for the control of the waters, be made with reference to the possible future development of the full water-power that may be available. For example, suppose a certain waterfall is capable of yielding 10,000 H.P. If development rights are let to A for 2,000 H.P., to B for 1.000 H.P., and to C for, say, 1,000 H.P.; and A, B and C are allowed to design and construct their respective works irrespective of each other, or of the possible development of the remaining 6,000 H.P., then, it will probably become quite impracticable to get anything like the remaining 6,000 H.P., because of the damage that would be caused to the plants of A, B and C. On the other hand, if preliminary works were constructed with a view to utilizing any amount of power up to the full 10,000 H.P., as occasion demanded, no such contingency as has been supposed could well arise.

More Complete Data Essential

The problem of ascertaining within reasonable limits what is the probable full amount of power which any particular water-power site may be made to yield, is one that calls for much more reliable data of fact than is furnished by scattered and non-consecutive gaugings, or measurements of rainfall, stream flow and other factors entering into the problem. The data required for a proper presentation of the water-power possibilities of any territory cannot be furnished unless a series of observations, extending over a sufficient period of time

to give the annual and other regimens of the various lakes, streams and rivers, is available. If the effect of rainfall upon run-off is taken into full consideration in connection with the study of water-power problems, then a series of records covering gaugings of rainfall and stream flow should extend over some fifteen or twenty years before prediction of the regimen of the waters of a watershed may safely be made to within, say, 5 per cent. of the facts.*

An approximation of 10 per cent., or even 20 per cent., may be sufficiently close for the majority of projected water-power development schemes; but when the range of approximation ranges from, say, 20 per cent. to 40 per cent. the uncertainty is apt to be too great to satisfy commercial requirements.

To supply the necessary data, a knowledge is required of the topography, and other characteristics of the watersheds; of the variations in the discharges of the water-courses contributing their flowage to the water-powers; and a knowledge, also, of the amounts and variations of the annual rainfall, and evaporation. The basis for the analysis and consideration of this class of information is a reliable map giving the results of an adequate topographic survey of the watersheds involved, and showing, where necessary, the contours of the country. It will be recognized, therefore, how important it is that topographic maps should be made showing the areas of the drainage basins, the locations of possible reservoir sites, and their relative altitude and location with regard to irrigable lands, and to water-power and navigation resources. While it is recognized that it may not be practicable, at the present time, to prepare a general map to include reservoir sites, minor watercourses and other more detailed information, it is, however, highly desirable, and indeed necessary, that topographic contour maps be prepared, at least for districts where development work is contemplated and likely to be performed.

The necessity for acquiring such information has been recognized by the Government of the United States and, since 1895, it has been conducting a systematic investigation for determining the water supply of that country. This work has involved the gauging of streams, the investigation of underground currents and artesian wells, and the preparation

* George W. Rafter, in *Relation of Rainfall to Run-off*, Washington, 1903, W. S. Paper No. 80, p. 18, says: "Further, it can be stated that, for records from twenty years to thirty-five years in length, the error may be expected to vary from 3.25 per cent. down to 2 per cent., and that, for the shorter periods of five, ten and fifteen years, the probable extreme deviation from the mean would be 15 per cent., 8.25 per cent. and 4.75 per cent., respectively." Rafter says, further, that with less complete records, "Mr. Henry reached the conclusion that at least 35 to 40 years' observations are required to obtain a result that will not depart more than ± 5 per cent. from the true normal. The average variation of a 35 year period was found to be ± 5 per cent. and for a 40 year period ± 3 per cent."

of reports upon the best methods of utilizing the water resources. During the years 1901 to 1910 inclusive, the Government appropriated $1,450,000 for this work, and, in addition, individual states expended large sums for similar investigations.

In 1910, the United States Department of the Interior published *Water Supply Paper* reports in which are given summary tables of the discharge per square mile. These are given, in order to allow of a ready comparison of relative rates of run-off from different areas in the various drainage basins and to show, in a general way, the seasonal distribution of run-off and the effect of snow, ground, surface, and artificial storage.

Caution Necessary in Using Data

We may now consider the general character of some of the information bearing upon the water-powers of Canada, as recorded in the various reports, and upon maps, issued by Departments of the Federal and Provincial Governments.

The maps of the portions of Canada in which the greater number of water-powers exist, have been constructed largely from data collected by exploration and survey parties whose commissions were chiefly of the nature of what might be termed "reconnaissance work," with such main objects in view as determining the general geological structure, the outstanding topographic features, and the extent and general character of the forest, agricultural, arid, or other sections of the country. Since the lakes, rivers and streams usually constitute the natural highways through such territory as northern Canada, these explorers have usually indicated on their plans obstructions to navigation, such as falls and rapids. While the limitations of the information regarding the water-powers collected in such reports have been recognized, it has, nevertheless, been deemed advisable to collate several of the principal statements found in them.

In this connection it is suggested that, the importance of water-power data being now generally recognised, it should be a part of the standing instructions of all surveyors and explorers in the employ of governments in Canada to embody in their reports the most accurate information available in regard to water supply and water-powers in the territory traversed or explored by them.

Great caution, however, must be displayed respecting the uses made of this information. But little confidence can be placed in any reports of water-powers not based upon actual measurements, for, without measurements, the best judgment of explorers, and even of engineers, as to the heights of falls, and the amounts of water discharging over them, is frequently very wide of the results disclosed by actual measurements.

This is well illustrated by an experience related by the engineer in charge of much of the field-work of stream gauging for the Hydro-Electric Power Commission. This engineer stated that prospectors who had been at the falls on the Kawashkagama river, told him, in good faith, that the

falls were capable of developing 30,000 H. P. at low water; and he was further assured by a surveyor, who claimed familiarity with what he was speaking about, that the Kawashkagama river was able to yield as much power as the Kaministikwia river. After a hard journey, the engineer arrived at the falls, and, instead of the 30,000 H.P. reported, found the 317! H.P. given for the Kawashkagama river in the Report of the Hydro-Electric Power Commission. If these prospectors had published a report of their mining or geological investigations and incidentally mentioned that 30,000 H.P. could be developed at low water on the Kawashkagama river, such an assertion would have been very misleading.

General Statements Criticized

A very large percentage of the surface of Northern Canada is covered with water and, when the subject of water-power has come up for discussion, it has frequently been pointed out that, because there is so great a water area, there must be a correspondingly large amount of water-power.

Canada has an estimated water area of 125,755 square miles. Hence, as compared with the estimated area of 52,630 square miles of water area in the (continental) United States, Canada is seen to have nearly two and one-half times the water area possessed by the States.* The estimated water area of the province of Ontario is 40,354 square miles exclusive of any portion of the Great lakes, or any arm of the sea, and this area is over 75 per cent. of the total water area of the United States, exclusive of Alaska, the Philippines, and other external possessions.

Such computations and comparisons, while interesting and valuable for some purposes, are apt to be very misleading, especially if used—as they have been used—to suggest that the total amount of water-power is great because associated with so much water. But water is not necessarily water-power.

This fact may be well brought out by a reference to one of the large area water resources of the provinces of Ontario and Quebec, lake Abitibi. Here is a body of water which has a surface area of nearly 400 square miles. This is more than the total water area of Nova Scotia; more than five times the total water area of New Brunswick; and more than the water area of many of the individual states, such as New Hampshire, Connecticut, Pennsylvania or Rhode Island. When referring, in his "Report on the Lakes and Rivers, Water and Water-powers of the Province of Ontario," to the remarkable shallowness of so many of the lakes on the plateau forming the height-of-land between the Great lakes and

* The data relating to areas in Canada are taken from the Department of the Interior, *Atlas of Canada*, Ottawa, 1906, p. 4; and the areas in the United States, from U. S. Geological Survey Bulletin No. 302, *The Areas of the United States, the States, and the Territories*, Washington, 1906, pp. 7–8.

Hudson bay, Mr. E. B. Borron says that the mean summer depth of Abitibi lake would not exceed ten feet. He also adds:

> "The soundings taken by us on the south side of the lake never exceeded nine feet, even in the widest stretches and when farthest from the shore. I have been told, however, that it is somewhat deeper on the north side of the lake, though shallow even there..... The result of upward of five hundred soundings taken in all parts of these lakes during the months of July and August (1888) went to show, as regards the upper or easterly division of lake Abitibi, a mean or average depth of eight feet four inches only; the greatest or maximum depth in the open lake being fourteen feet.
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> In the lower section or division of lake Abitibi, the mean of the soundings taken was nine feet four inches, and the maximum depth, twelve feet. No soundings were taken near shore, where (there is) less than four or five feet in depth."*

From the above data, it may be estimated that the amount of water stored in lake Abitibi would probably be under 111,000 million cubic feet. Now the total water area of the state of Pennsylvania is under 300 square miles, or only 75 per cent. of the water area of lake Abitibi. At the present time there are installed in Pennsylvania water wheels of a rated capacity of about 300,000 horse-power.† If there was any reason for citing the amount of water area as a fact at all indicative of the amount of power associated therewith, one might infer that, if 300 square miles of water surface could justify Pennsylvania in installing nearly 300,000 horse-power of water wheels, lake Abitibi, with 33 per cent. more area, might have somewhat corresponding possibilities for power in the discharge of its waters. If, however, its natural flowage and the waters stored in the lake itself were expected to supply this amount of power at Couchiching falls, situated a few miles from the outlet of the lake, the whole lake would be drained dry in less than a month, and even if the whole of the fall from the lake to the sea were available, the lake Abitibi waters, in attempting to supply the 300,000 H.P. above referred to, would be exhausted in about a year.

It must be recognized that no attempt has been made to consider this hypothetical case on other than broad lines, and then only for the purpose of emphasizing the particular point of the matter raised for discussion, viz., that water area is no indication of water-power possibilities, unless the water areas are considered in relationship to the quantities of the waters as well as to the physical features of the territory in which such waters are situated.

What is true of generalizations respecting water areas is also correspondingly true of watershed areas. In the United States, the Northern

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* Report published in Ontario, Sessional Papers, 1892, No. 3, pp. 9 and 11.

† More exactly, 290,990 H. P., as given in the *Statistical Abstract of the United States*, No. 31, Washington, 1909, p. 26.

"THE NOTCH," MONTREAL RIVER, ONT.

Pacific drainage basin, including all the Pacific Coast streams north of San Francisco, and also the Sacramento and Columbia rivers, has a drainage area of less than 300,000 square miles,* or about 7 per cent. of the total of the principal drainage areas of the United States; and yet 30 per cent. of the total available water-power in the United States is contained within this Northern Pacific drainage area. Thus, 30 per cent. of the total water-power of the United States is associated with only 7 per cent. of the total drainage area.

In Canada, there is an enormous watershed area which, through many great rivers, drains its waters into James bay. Considering these waters in their descent from the height-of-land to the sea, they would yield, *theoretically*, an enormous amount of water-power; but, if one had in his possession sufficient reliable topographical and other necessary data appertaining to the waters he was considering, then it would probably be discovered that the amounts of the theoretical and economically usable water-power were widely different quantities.

In referring to the waters of the James Bay watershed, in his "Report on the Lakes and Rivers, Water and Water-Powers of the Province of Ontario," E. B. Borron says:

> "North of the height of land plateau, the percentage or proportion of the power practically recoverable from the water of the rivers which flow into James bay will be less. These rivers between the northern edge of the height of land plateau and the foot of the long portages descend in general from six to eight hundred feet. The rapids and falls are numerous and capable of affording, in the aggregate, an enormous amount of power; but there are comparatively few "still water stretches" between the water-falls, and hence a considerable loss. Again, below the "Long Portages" these northern rivers flow for a distance varying from 70 miles in the case of the Abitibi, to 200 miles in that of the Albany river, over a plain or flat belt of country lying to the south and west of James bay. In this stretch, there is a fall or descent varying from 200 to 400 feet. Theoretically, the water is capable of affording an immense amount of power, but practically, owing to the gradual descent, very little is recoverable."†

It will be comprehended, therefore, that watershed area, *per se*, may, or may not, have any specially significant bearing upon the amounts of available water-power associated therewith. General statements implying that "the aggregate amount of water-power must be great because the total water area, or watershed area, is so great", or "because there are so many lakes and rivers," are generalities to be considered of very little definite value.

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* The area of the Northern Pacific drainage basin is taken from M. O. Leighton's article on *Water-power in the United States*, in *The Annals of the American Academy of Political and Social Science*, May, 1909, p. 65.

†Borron's Report, p. 27.

There are other considerations, too, which detract from the value of water area as an index of the amount of power available. For instance, in the northern portions of Canada there is no doubt but that some of the shallow waters are frozen solid for a number of months each year, and the flow of other waters is so impeded by anchor and frazil ice as to render them, during the frozen periods, practically useless for power purposes. Furthermore, increased water area may, in certain territories, correspond to excessive evaporation.

The illustrations that have been used also suggest the need for acquiring adequate data which set forth the topographical and other main features of the territories in which water-powers are located. In each instance, what is required is reliable and sufficient data of fact obtained in the field. Where this class of data is not possessed, care should be exercised not to group the estimated water-power possibilities of, say, a province, or a large section of a province, indiscriminately, for the purpose of impressing people with the grand total of water-power available, unless, at the same time, full emphasis is laid upon the fact that such generalizations are apt to be exceedingly misleading.

One of the chief dangers of giving undue place to such generalities, is to create in the mind, and especially in the popular mind, a feeling of unwarranted assurance that, even though desirable water-power rights are being granted by a government, yet there is so much left that no apprehension may be entertained regarding the amount of power rights being parted with. Many persons are apt to forget that the dissemination of such generalities is too often part of a plan to make easy the acquisition, by interested parties, of the most coveted privileges.

Exceptional Natural Reservoirs of Canada

There is, however, one excedingly valuable feature very likely to be associated with extensive water areas, and this is the existence of vast natural reservoirs, where the run-off from precipitation is impounded, and subsequently discharged gradually throughout the year. Thus, water-powers situated within the range of the direct influence of such natural storage reservoirs may be of incomparably greater value than other water-powers not so favoured. This is a matter which should be taken into full consideration when the classification and the values of water-powers are being determined. In the matter of easily developed water-storage systems, no other large territory on the American continent is so highly favoured as is the Dominion of Canada.

When the subject of storage reservoirs is under consideration, it should not be forgotten that Nature also stores her waters elsewhere than in lakes and rivers. Forest floors, extensive areas covered with plant growth and the great swamps of the country, each and all, constitute valuable water reservoirs. In such reservoirs there is a widespread and satisfactory distribution of waters, which enables Nature to yield her

supplies gradually and as required. A discreet conservation and utilization of such reservoirs will, in general, be found to be much more desirable than are some of the large artificially constructed reservoirs, where the liability of accidental destruction of large construction works is always more or less of a menace.

Reconnaissance Surveys

When knowledge of the quantities of water-power that may be available in particular places is required on short notice, and when sufficient records of actual observations do not exist, it is possible to *estimate* the probable amounts of power available. For such preliminary estimates data are secured by what may be termed a reconnaissance survey of the general situation; but it must be recognized that the conclusions reached by such methods are not comparable with the results deducible from actual observations of individual water-power conditions extending over a series of years.

It will be profitable to explain very briefly these reconnaissance methods for estimating water-power. First, the area of the watershed in question is ascertained by measurement from the best available maps; to this area is applied an *assumed* run-off coëfficient such as would be suggested by a general knowledge of the precipitation and of the topography and other characteristics of the territories involved. The wise choice of the coëfficient used, will, of course, depend upon the good judgment and knowledge possessed by the engineer. This run-off coëfficient, as it is termed, is a quantity which represents the amount of water that may be drained off any specified area during a stated period, and is usually expressed as so many cubic feet per second per square mile. Obviously, if the area of a watershed is known to be so many square miles, and each square mile, under specified conditions, will yield so much water, then, the total yield of water from the whole watershed will be the product of the factors just mentioned.

When the discharge of a stream, or river, is actually measured,* it is

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* Where sufficient records of gauge heights and corresponding discharges of stream flow are available, the low-water and other flows may be estimated with remarkable accuracy. From such records, discharge, mean velocity, area and other curves or tables may be constructed in terms of the gauge heights; and therefrom, reasonably safe deductions may be made.

This method has been pursued in the case of the Ottawa river by the Georgian Bay Ship Canal Survey. See report of same, especially Plates Nos. 54, 55, 56, giving discharge curves, etc.; For the Winnipeg river, see W. Thibaudeau's report on *Investigation of Water-Power on Winnipeg river*, in *Annual Report of the Topographical Surveys Branch*, 1907–1908, with accompanying maps, Ottawa, 1909; pp. 174–178. Also consult *Reports of Progress of Stream Measurements*, issued by the Department of the Interior, Canada.

For excellent representative examples of methods, and reports of investigation into the water-power resources of individual States in the United States, consult *Hydrographic Manual* of the United States Geological Survey, (being W. S. and Irr. Paper

usually accomplished by means of floats, or by using a current meter. The principles involved are very simple. They consist essentially of measuring the velocity of the flow of the stream by means of the floats or meter, and measuring, also, the area of the cross section of the river at the place for which the velocity has been thus obtained. The volume of the water which passes a given point is the product of the area of the cross section of the stream and the velocity of flow at that point.

A concrete illustration will make these methods of estimating clearer. Take, for example, the case of a water-power like Healey falls on the Trent river. The fall is here considered to have an effective head of sixty feet, and we will further suppose that it is desired to ascertain the horse-power available at low water. From the map of the district it would be ascertained by measurement that the drainage area above the fall is about 3,630 square miles. If the engineer had previously ascertained that the run-off in some other similar territory was ·4 feet per second per square mile, he would use this coefficient and thus obtain an *estimated* run-off or discharge of 1,452 cubic feet of water per second (3,630 square miles $\times$ ·4). Assuming water wheels of 80 per cent. efficiency, this 1,452 cubic feet of water per second, with a fall of 60 feet, would give approximately 8,000 horse-power.† If actual, yet insufficient, discharge measurements were made at Healey falls such data would be criticized by the engineers, according to the time of the year at which they were made, in order to deduce what the Trent river would discharge at its

No. 94), Washington, 1904; also *Progress Report on Water-Power Development by New York State Water Supply Commission,* Albany, 1908; also *Fourth, Fifth and Sixth Annual Reports of the New York Waterways Commission,* Albany, 1909, 1910, 1911; also *Report on Water Supply, Water-Power, the Flow of Streams and Attendant Phenomena,* (by C. C. Vermeule), Geological Survey of New Jersey, Final Report, Vol. 111., Trenton, 1894; also Water-supply Series (N), of the *Water-supply and Irrigation Papers of the U. S. Geological Survey,* including Reports upon the water-powers of the State of Maine (No. 69); Texas, (No. 105), Alabama, (No. 107), Northern Wisconsin, (No. 156). For *Weir Experiments, Coefficients and Formulas,* consult Water Supply and Irrigation Paper No. 200.

† The theoretical horse-power available at any point on a stream, is the product of the effective height through which the water falls, and the weight of the water falling in a given time. Thus:

Let Q represent the flow of water in cubic feet per second.
h represent the effective fall in feet.

$$\text{Horse-power} = \frac{5\ Qh}{44}$$

Considering a good turbine to develop 80 per cent. of the theoretical power, we have

$$\text{Horse-power} = \frac{Qh}{11}$$

Hence a simple rule for obtaining the horse-power that may be developed under favourable conditions is: *Multiply the flow in cubic feet per second* (Q), *by the effective head in feet* (h), *and divide the result by* 11.

lowest stage, and this quantity, so derived, would then serve as a check upon the flow estimated by means of the previously assumed run-off coefficient and drainage area.

It would be well when water-power data are published if the precise conditions upon which the estimates are made were also indicated. Sometimes there exist what appear to be discrepancies in different data for the same power sites, and, owing to the lack of explanatory information, no conclusion can be formed respecting the correct explanation of the seeming discrepancies. Very often ambiguities arise from the fact that the heads have been selected between different points.

Résumé and Summary In concluding this general introductory survey, some of the principal conclusions reached may be briefly summarized as follows:

First.—Water-power is dependent, primarily, upon precipitation. Other interests such as municipal and domestic water supply, navigation, agriculture and irrigation are likewise dependent upon the same source. The subject of water-powers, therefore, can not be properly considered without making fair allowances for the demands of the other interests that have just claims upon water as a natural resource.

Second.—Knowledge of the physical circumstances intimately associated with water-powers is essential to an intelligent classification of them. It is as unreasonable not to differentiate between water-powers as it would be not to differentiate between timber tracts, mineral lands, or the items of any other natural resource varying in quantity, quality and situation.

Third.—The accuracy of published data relating to water-powers must be accepted with qualifications, unless that data is based upon carefully ascertained facts obtained in the field.

Fourth.—General statements, so commonly made, of vast numbers of existent water-powers are misleading and tend to disguise the fact that the number of water-powers in Canada, at present desirable from an economic standpoint, is much smaller than generally supposed.

Fifth.—Reliable data upon water-powers have definite characteristics. At the present time, there is urgent need for such data and for detailed topographical maps.

Sixth.—Certain steps are necessary to secure water-power data that are thoroughly reliable. Metering stations should be established at carefully selected points on the principal rivers and streams, and accurate cross sections of the river beds made at such stations. Permanent benchmarks should be established. A substantial gauge should be erected in an accessible place at each gauging or metering station. Carefully conducted discharge measurements could then be made from time to time during the year, and gauge readings could be taken daily, by some reliable person resident in the locality; or, on the more important rivers, self-registering

gauges could be installed. As a result of such procedure, rating tables could be prepared to show the discharges at all stages of the water. Thus, in the course of a very few years, recorded data of fact would be on file, and from such data the maximum, minimum and mean monthly and mean yearly discharges could be ascertained. Furthermore, if the areas of the drainage basins of the respective watersheds are known, and information upon the rainfall is available, important deductions relating to the run-off may be made. If good "common sense" judgment were exercised in the selection, equipment and arrangements for the maintenance of gauging stations much valuable and reliable information could be obtained for a comparatively limited initial outlay and subsequent annual expenditure.

Summary of Water-power Developed in Canada

Owing to the paucity of information available respecting water-powers in Northern Canada and the northern portions of the various provinces and, also, respecting many of the minor powers in the settled area, it has not been considered advisable to make an estimate of the total water-power in Canada. One "estimate" places it at nearly 17,000,000 H.P.; but it does not, and cannot, rest upon any basis of reliable information.

The information procured, however, justifies the publication of the following table showing the total water-power developed in Canada in 1910, and the principal industries using it:

WATER-POWER DEVELOPED IN CANADA

Province	Electrical Energy	Paper and Pulp	Other Industries	Total
	H.P.	H.P.	H.P.	H.P.
Ontario*	400,683	57,575	74,008	532,266
Quebec	191,252	76,926	31,975	300,153
Nova Scotia	1,875	12,000	1,397	15,272
New Brunswick	3,400	3,050	3,315	9,765
Prince Edward Island	50	.....	450	500
Manitoba	48,250	.....	50	48,300
Saskatchewan	.....	.....	45	45
Alberta	7,300	.....	.....	7,300
British Columbia	88,145	8,500	4,275	100,920
Yukon	2,000	.....	.....	2,000
Total	742,955	158,051	115,515	1,016,521

*Includes all Ottawa River powers between Montreal and lake Timiskaming, whether wholly in Quebec or in Ontario, or partly in each.

KAKABEKA FALL, KAMINISTIKWIA RIVER, CNT.

CHAPTER III

The Water-Powers of Ontario

PRIOR to 1898, no statutory regulations had been made by the Ontario Legislature to govern the lease or other disposal of water-powers, *per se*, situated upon lands possessed by the Crown. Previous to that date Crown patents for land carried with them the title to all water-powers situated upon the lands conveyed. Even if, before a patent was granted, a water-power was known to exist upon the land to be conveyed, it was not necessarily referred to in the patent.

Nevertheless, the water-powers so granted were by no means free from legal restrictions, nor are they now.* All water-powers, whether granted before 1898, or after, are subject to conditions imposed by law in the interests of navigation, of public health, of lumbermen and of the riparian owners.

Statutory Enactments

Earlier Enactments

On January 17th, 1898, the Ontario Legislature passed the following Act respecting water-powers:—

> "Her Majesty, by and with the advice and consent of the Legislative Assembly of the Province of Ontario, enacts as follows: The Commissioner of Crown Lands may reserve from sale any water-power or privilege on the Crown Lands of the Province, and a sufficient area of land in connection therewith for the erection of buildings and plant, together with the right to lay out and use such roads as may be necessary for passage to and from such water-power or privilege and land, and may, under regulations to be approved by the Lieutenant-Governor

*In seeking to determine the water rights and privileges which now exist under early patents, care should be exercised to ascertain what restrictions may have been applied in special cases owing to special forms used for grants, to orders in council, and to other governing factors.

For example, on January 22, 1821, in respect to certain deeds for land in Innisfil, Upper Canada, about to be granted to William Allan, the Surveyor General wrote to the Lieutenant-Governor in Council to ascertain whether "one chain on the top of the bank is to be reserved—and whether generally, on all principal Navigable Waters I am to consider such allowances to be reserved to the Crown in the Patent Deeds." After reading this communication it was "Ordered that on Navigable Waters the Rule should be general to reserve for the public, the Beach and one chain for a Road." (See Upper Canada Land Book L; pp. 70 and 77; Canadian Archives, Ottawa).

Again, the *free* grant Patent used for Upper Canada (Ontario), in 1832, conveyed "the land together with all the woods and waters thereon lying and being, under the reservations, limitations and conditions, hereinafter expressed;" whereas grants by *sale* in the same year, 1832, had the following reservation clause:

"Saving, excepting, and reserving nevertheless unto us, our Heirs and Successors, all mines of gold and silver, and the free uses, passage and engagement of, in, over and upon all navigable waters that shall or may be thereafter found on or under, or be flowing through or upon any part of the said parcel or tract of land hereby granted as aforesaid."

See also, the Bed of Navigable Waters Act, 1 Geo. V, chap. 6, Ontario.

in Council, make terms and conditions upon which such water-power and land so reserved may be sold or leased and developed."*

On June 21st, 1898, under this "Act Respecting Water-Powers," the Lieutenant-Governor approved an Order in Council for "Regulations *re* Water-Powers."† These regulations applied to "water privileges which, in their natural condition at the average low stage of water, have not a greater capacity than 150 horse-power."

Present Regulations

On Jan. 16, 1907, the Regulations of June 21, 1898, were rescinded. New regulations were adopted, whereby supervisory and other discretionary jurisdiction over proposed water-power developments was vested in the Hydro-Electric Power Commission of Ontario. These regulations are now in force and are as follows:

1. These rules and regulations shall not apply to water privileges which in their natural condition at the average low stage of water have not a greater capacity than 150 horse-power.

2. In granting or leasing, otherwise than under these regulations, any Crown Lands upon which a water privilege is situated, or which may be flooded, or overflowed in consequence of the development and utilization thereof, the said privilege shall be reserved to the Crown, together with such an area of land in connection therewith as shall in the opinion of the Minister be required for the proper development of the same, and the construction of all necessary dams, weirs, tunnels, races, flumes, sluices, pits and other structures or works, and the erection of buildings and plant for the employment and utilization of such privilege, and storing grounds and yards in connection therewith; and there shall also be reserved in any such grant or lease, the right to flood any portion of the lands so granted or leased upon compensation to be made to the owner or lessee thereof by the person or persons to whom such privilege shall afterwards be leased; and the said water privilege, land and right so reserved shall form a separate property and may be dealt with as hereinafter provided.

3. The right to lay out and use such roads as may be necessary for the passage to and from such water privilege or land shall be reserved in all grants or leases of contiguous or adjoining lands.

4. The applicant for a water privilege situated on Crown Lands shall file in the Department of Lands, Forests and Mines a plan and field notes by an Ontario Land Surveyor of survey thereof; and also a report by a competent engineer satisfactory to the Minister showing:

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* 61 Vict., chap. 8.

† The regulations of June 21st., 1898, are re-printed in an article, *Water-Powers of Ontario*, by Thomas W. Gibson, in the *Ontario Bureau of Mines Report*, 1898, Vol. VII, Pt. 3, pp. 251-6. The Regulations of Jan. 16, 1907, have been published in pamphlet form by the Ontario Bureau of Mines.

(*a*). The location of the water privilege applied for, and a description of the land required in connection therewith.

(*b*). The height of the fall or rapid, the volume of water at the average high and low stages of same, the estimated capacity in horse-power of the fall or rapid in its natural condition at the average low stage of water, the height of the dams or weirs (if any) which it is proposed to construct, and the increase in the level of the water which such dams or weirs will bring about.

(*c*). The plan by which the applicant proposes to develop the water privilege, showing the dams, weirs, tunnels, races, flumes, sluices, pits and other structures or works which it is proposed to build or make in connection therewith, the estimated cost thereof, and the form in which the power is to be used or transmitted, that is, whether by direct energy, electricity, compressed air, etc.

(*d*). The land or lands which would be overflowed or otherwise affected by the raising of the water or the construction of the dams, weirs, sluices, races or other works in connection with the development or use of such water privilege, and the owner or owners thereof.

The applicant shall also show the nature and location of the business, plant or manufactory in connection with which it is proposed by the applicant to utilize the water privilege, and the number of horse-power which the applicant proposes to develop and utilize; and shall furnish proof satisfactory to the Minister that the said water privilege is required for the applicant's own mechanical or industrial purposes or to supply an actual or anticipated demand for power in the neighborhood of the privilege.

Provided that the Minister may dispense with the requirements of any of the preceding clauses of this regulation in case the information, plans, etc., required to be furnished are already in the possession of the Department of Lands, Forests and Mines.

5. If so required by the Minister, the applicant shall furnish at his own expense all such measurements, plans, specifications, descriptions, levels, profiles, elevations and other information as he may deem necessary for the proper consideration of the application; and the applicant shall also, if required, submit to the Hydro-Electric Power Commission of Ontario the plans and specifications showing the proposed works for the development of the said privilege and such works shall not be proceeded with until the said Power Commission has approved the same.

6. The applicant shall submit such proof of his financial standing and ability and intention to develop the said water privilege as shall be satisfactory to the Minister.

7. Before the lease of a water-power is granted the Minister may require the applicant to deposit with the Treasurer of the Province a sum of money to be named by the Minister, conditional upon the carrying out of the works of construction and development specified in the lease within the period therein named; such sum to be returned to the lessee upon due fulfilment of such condition; otherwise to be forfeited to His Majesty the King for the use of the Province of Ontario.

8. Upon compliance with the foregoing regulations and upon approval of the application by the Minister in writing, he may order a lease of the water privilege to be issued to the applicant upon such terms and conditions and at such rental as may be fixed by the Minister. The rental reserved by any such lease or any renewal thereof shall be payable yearly in advance.

9. No such lease shall be granted for a longer term than twenty years, but the lessee shall have the right of renewal of such lease for two further and successive terms of ten years each upon such terms and conditions as may be agreed upon or may be fixed by the Minister.

10. The right of timber owners and others to drive their logs or timber down any stream, river or other body of water, as now by law established, shall not be interfered with, lessened or restricted by the granting of any such lease; and if any dam, weir or other structure be erected or built in connection with the development of any such privilege, with the object, intention or effect of damming the water or impeding the flow thereof, full and proper provision, as now by law required, shall be made by the lessee for the safe and convenient passage of logs and timber over and through the same.

11. The lessee under any such lease shall not destroy or obstruct the navigation of any river, stream or body of water previously navigable; but shall provide such locks, canals, passages and other means as may be necessary for the proper and safe surmounting or passing of any dam, weir or other work made or erected by the lessee, and as may be required for purposes of navigation by the Government of Canada.

12. In addition to any other conditions or provisions required by the Minister, the lease shall contain conditions and provisions to the following effect:

(*a*). Requiring the development and use within a period or periods to be named in the lease of a specified quantity or quantities of power or energy, estimated in horse-power.

(*b*). If the quantity of power required by the lease to be developed within a period or periods therein named is less than the full capacity of the said privilege, upon report being made by the said Hydro-Electric Power Commission to that effect, and also that there is a *bona fide* demand for power which can be supplied therefrom, the Lieutenant-Governor in Council may, by Order in Council require the lessee to develop the said privilege to its full capacity or to such other extent as he may deem proper or requisite within a period or periods of time to be named in the said Order.

(*c*). For the use by other parties than the lessee of surplus or unused water or power not required by him for the purposes of his business, plant or manufactory, on such terms as may be agreed upon.

(*d*). Failing an agreement between the parties concerned as to the rates or conditions for supplying power by the lessee to any person, company or corporation, or by any person, company or corporation receiving power from the said lessee, and any other person, company

or corporation, either party may submit the matter to the said Power Commission, and any Order made by the Lieutenant-Governor in Council upon report thereon by the said Power Commission fixing and determining the said rates and conditions shall be final and conclusive and binding upon all parties concerned.

(*e*). In case of submission to the Hydro-Electric Power Commission as in paragraph "(*d*)" herein mentioned, the said lessee on being so required by the said Commission shall produce all books, accounts, records and statements verified by affidavit showing the cost of constructing, equipping and maintaining the works for the development of the said privilege and delivering the power therefrom.

(*f*). Upon complaint in writing being made that any municipal corporation is granting bonuses by supplying power, light or heat below cost to manufacturers or others, whether the said corporation is the lessee of a water privilege or is receiving power therefrom from or through such lessee, the Lieutenant-Governor in Council may refer the matter to the said Hydro-Electric Power Commission, who may dispose of the same in manner provided by Chapter 15 of the Ontario Statutes of 1906, or any amendment thereto.

(*g*). For the purpose of ascertaning the quantity of power actually developed or capable of development from any water privilege or the amount of rental payable under a lease thereof, said Power Commission or any engineer appointed by it for that purpose shall have free access to all parts of the works, and all books, plans, or records bearing on the quantity of power, and may make measurements, take observations, etc., and any calculation as to the quantity of power so developed or capable of development made by the said Commission or by such engineer shall be binding upon the lessee.

(*h*). The power and authority to acquire water-powers and works by purchase, lease or otherwise, or without the consent of the owners thereof conferred upon the said Power Commission by Chapter 15 of the Statutes of Ontario of 1906, shall be exercisable by the said Power Commission in respect of any water-power leased under these regulations or any works connected therewith.

(*i*). During the construction of the works for the development of any water-power, the said Power Commission or any engineer appointed by it for that purpose shall have free access to all parts of the works for the purpose of inspecting the same, and of ascertaining that the construction thereof is in accordance with the plans and specifications approved by the said Power Commission.

(*j*). For the erection and maintenance by the lessee of a durable and efficient fishway when so required by the proper officer or authority in that behalf.

(*k*). During the continuance of the lease, the lessee shall keep and maintain all dams, weirs, tunnels, races, flumes, sluices, pits and other structures and works necessary for the development and use of such privilege in good repair and condition, and shall not wilfully or otherwise injure or destroy the same, or any part thereof but at the expiry or sooner determination of the lease, shall leave all such structures and works in good repair and condition, reasonable use and wear thereof and damage by fire and tempest only excepted, and so that their subsequent usefulness shall not be lessened by any act of the said lessee.

(*l*). At the expiry or sooner determination of the lease, the water privilege shall revert to and become the property of the Crown as fully as if no such lease had been granted, together with all dams, weirs, tunnels, races, flumes, sluices, pits and other structures or works made or erected by the lessee in connection therewith, and all buildings erected on land covered by the lease; but the lessee shall be allowed a reasonable time to be fixed by the Minister in which to remove all machinery employed by him in the development and use of the privilege, failing which removal such machinery shall become the property of the Crown. Provided that where any such buildings or structures are of a permanent character and necessary or useful for the proper development or utilization of the water privilege, the Lieutenant-Governor in Council, may upon report in that behalf by the said Hydro-Electric Power Commission, pay the lessee by way of compensation therefor and purchase thereof, such sum or sums as he may deem proper upon the same being appropriated for the purpose by the Legislative Assembly of the Province.

(*m*). The lease shall at all times be subject to any general regulations thereafter made by the Lieutenant-Governor in Council affecting the construction and operation of works for the development of water privileges or the supply of power therefrom.

13. The Lieutenant-Governor-in-Council may cancel any water-power lease issued under these regulations for non-payment of rental within 90 days after the same is due and payable, whether the same shall have been demanded or not, or upon report by the said Power Commission that the conditions as to construction of the works or the development or supply of power have not been complied with, or that at any time after the water privilege has been developed either in whole or to the extent to which the lessee is bound or required to develop the same the said lessee has continuously failed or neglected for the space of one year effectually to produce power from the said privilege, either for his own use or that of other persons, unless hindered by unavoidable accident, or that the lessee has failed or neglected to comply with any of the conditions of the lease or any Order in Council respecting any matter or thing arising under the lease concerning which such Order is made; and publication of any Order in Council cancelling such lease shall be sufficient proof that the same has been duly and lawfully cancelled. Provided due notice shall be given a lessee before such cancellation in order that he may have an opportunity of being heard, should he so desire.

14. Where a water privilege is applied for by a municipal corporation for the purpose of supplying water, power, light or heat for the use of the inhabitants of the said municipality, the Minister may issue a lease of said privilege to such corporation if otherwise entitled to receive and hold the same, on such special terms and conditions as may be recommended by the said Power Commission, and at such rental as he may deem proper.

15. The word "Minister" in these regulations shall mean the Minister of Lands, Forests and Mines, or any Minister of the Crown

performing the duties of the Minister of Lands, Forests and Mines in his absence or during a vacancy in that office; and the Minister may refer to the Hydro-Electric Power Commission of Ontario any application for the leasing of any water privilege or any matter arising out of such application or any lease made in pursuance thereof, whether hereafter or heretofore issued, for consideration, investigation and report.

16. No water-power lease shall be valid or effective unless the same is issued under the Great Seal of the Province and is signed by the said Minister.

Since 1898, therefore, water-power privileges in Ontario have been retained by the Crown as an asset separate from the lands immediately adjacent to them. Prior to that date, many water-powers had been disposed of without any systematic records having been made of them. It would now be difficult to ascertain the present owners and terms of sale, or lease of these, except by searching the records in the local registry office.

Form of Lease

The following is a copy of the form of lease that is now used in disposing of power privileges:

Province of Ontario

George the Fifth *by the Grace of God of the United Kingdom of Great Britain and Ireland, and of the British Dominions beyond the Seas,* King, *Defender of the Faith, Emperor of India.*

To all to whom these Presents shall come—Greeting

Know Ye *that by virtue and authority of chapter eight of the Statutes passed by the Legislative Assembly of the Province of Ontario in the year of Our Lord One thousand eight hundred and ninety-eight and of the Regulations made thereunder adopted by His Honour the Lieutenant Governor in Council dated the Sixteenth day of January, One thousand nine hundred and seven, and in consideration of the provisoes conditions and restrictions hereinafter contained.* We *have demised and leased and do hereby demise and lease unto*

hereinafter called the Lessee, All and Singular Th *certain parcel or tract of land and land covered with water situate, lying and being at*

on the River, in the Province of Ontario, and more particularly described as follows

(Saving, excepting and reserving nevertheless unto Us, Our Heirs and Successors, all gold, silver, lead, copper, iron and other mines or minerals which are or shall be hereafter found on or under the said lands and all trees growing or being thereon) together with all advantages and appurtenances which may during the term hereby granted be held, occupied or enjoyed therewith.

To have and to hold the same with the appurtenances unto the said lessee , for the full end and term of twenty years to be computed from the day of One thousand nine hundred and , yielding and paying unto Us, Our Heirs and Successors in advance at the Treasury Department, Toronto, yearly and every year during the said term hereby granted in lawful money of Canada the sum of
dollars for

the first of such payments to be made at or before the execution or delivery of these presents, and subsequent payments on the day of . in advance in each and every year thereafter with the right of renewal of the said lease for two further and successive terms of ten years each upon such terms and conditions and at such rental as may be agreed upon or fixed or determined by the Minister at the time of such renewal or renewals.

Subject nevertheless to and this lease is made upon the provisions, conditions and stipulations following, that is to say:

1. The said lessee shall develop and utilize the water privilege situated on the lands hereby demised by the construction of the necessary works, the location of water wheels and the installation of suitable and necessary plant and machinery on the said lands for the generation of electricity, the compression of air or the production of some other form of power or force by means of the water flowing in or over that portion of the bed of the River situated on the lands hereby demised to the extent of not less than
horse-power within years from the date hereof.

2. The said lessee shall use the power so developed in the operation of machinery or some other commercial, mechanical or industrial purpose or if the said power so developed or any part thereof, shall not be required for such purpose or purposes by the said lessee he shall furnish to any person, company or corporation requiring the same power up to the amount of power hereby required to be developed or such lesser quantity as shall be actually required or in demand, or if a greater quantity of power shall be developed by the said lessee than the quantity which it is provided herein shall be developed, then up to the amount of power so developed. Upon report being made by the Hydro-Electric Power Commission of Ontario to the Lieutenant-Governor in Council that the water privilege aforesaid has not been developed and utilized to the full extent of its capacity by the works constructed or the water wheels, plant and machinery installed by the said lessee and that there is a *bona fide* demand for power in excess of the quantity of power developed and

utilized by the said lessee which might in whole or in part be supplied from the water privilege aforesaid, then the Lientenant-Governor in Council may by Order in Council require the said lessee to develop and render available for use the additional quantity of power so shown to be undeveloped and capable of development or any part thereof, by the construction of the necessary works, the location of water wheels and the installation of suitable and necessary plant and machinery on the said lands within a period of time to be named in the said Order, and in default of compliance with the said requirement the Lieutenant-Governor in Council may order and direct that this lease shall be forfeited and cancelled and the same shall be forfeited and cancelled accordingly.

3. Should the lessee or any person, company or corporation receiving power from the said lessee for distribution, and any other person, company or corporation desirous of obtaining power as aforesaid fail to agree upon the rate or price to be paid for the same, or the terms and conditions for supplying the same, either party may submit the matter to the said Hydro-Electric Power Commission, and any Order made by the Lieutenant-Governor in Council upon report thereon by the said Hydro-Electric Power Commission fixing and determining the said rates and conditions shall be final and conclusive and binding upon all parties concerned.

4. In case of submission to the said Hydro-Electric Power Commission, as in paragraph three hereof mentioned, the said lessee , if so required by the said Hydro-Electric Power Commission, shall produce all books, accounts, records and statements, verified by affidavit, of the cost of constructing, equipping and maintaining the works for the development of the said water privilege hereby demised, and delivering the power therefrom.

5. For the purpose of ascertaining the quantity of power actually developed or capable of development from the water privilege aforesaid or the amount of rental payable hereunder by the said lessee the said Hydro-Electric Power Commission or any engineer appointed by it for that purpose shall at all times have authority to enter upon the said lands hereby demised or any buildings or works erected thereon or any part thereof, or any other lands, buildings or works on or in or by means of which power from the said privilege is developed, and examine and inspect the same, and take measurements and make observations, and shall have free access to all books, plans or records bearing on the said quantity of power, and any calculation of the quantity of power developed or capable of development from the said water privilege made by the said Hydro-Electric Power Commission or by such engineer shall be binding upon the said lessee , and rent shall thereafter be paid and is hereby reserved at the rate of per horse-power per annum for the quantity of power developed as determined by the said calculation.

6. During the construction of the works for the development and utilization of the water privilege hereby demised, the said Hydro-Electric Power Commission or any engineer appointed by it for the purpose shall have free access to all parts of the works for the purpose of inspecting the same and of ascertaining that the construction thereof is in accordance with the plans and specifications approved by the said Commission.

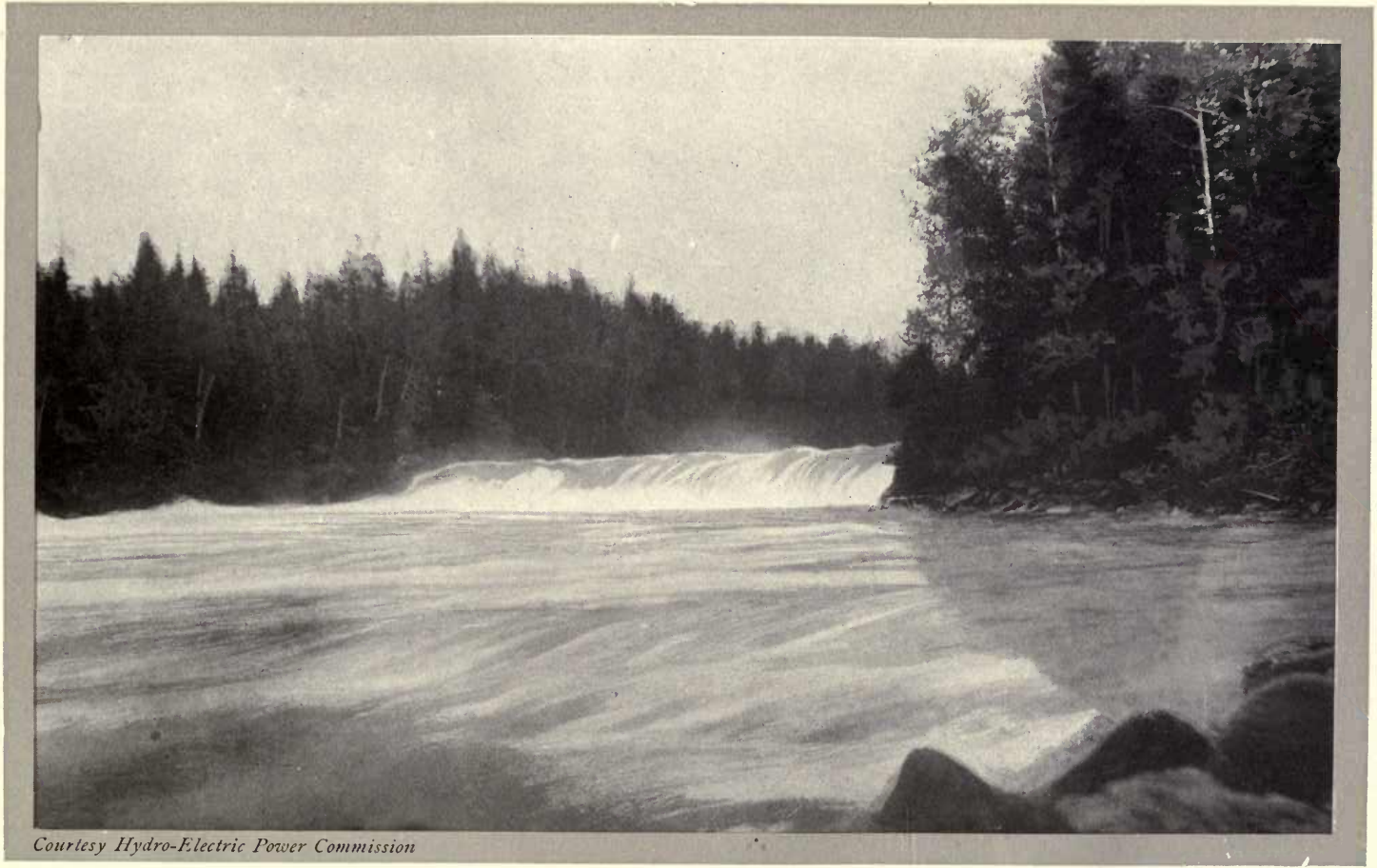
7. The granting of these presents shall not interfere with, lessen or restrict the right of timber owners or others to drive their logs or timber down the said River, or that part of it hereby demised; and if any dam, weir or other structure be erected or built in connection with the development of the water-power situated on the premises hereby demised with the object, intention or effect of damming the water or impeding the flow thereof, full and proper provision as now by law required shall be made by the said lessee for the safe and convenient passage of logs and timber over the same.

8. Upon complaint in writing being made that any municipal corporation is granting bonuses by supplying power, light or heat below cost to manufacturers or others, whether the said corporation is the lessee of the water privilege hereby demised or is receiving power therefrom from or through such lessee , the Lieutenant-Governor in Council may refer the matter to the said Hydro-Electric Power Commission, who may dispose of the same in manner provided by chapter fifteen of the Ontario Statutes of 1906, or any amendment thereto.

9. The said lessee shall whenever so required by the proper officer or authority in that behalf, erect and maintain a durable and efficient fishway for the free passage of fish at all times and seasons.

10. During the continuance of this lease the said lessee shall keep and maintain all dams, weirs, tunnels, races, flumes, sluices, pits and other structures and works necessary for the development and use of the water-power or privilege aforesaid in good repair and condition and shall not wilfully or otherwise injure or destroy the same or any part thereof, but at the expiry or sooner determination thereof shall leave all such structures and works in good repair and condition, reasonable use and wear thereof and damage by fire or tempest only excepted, and so that their subsequent usefulness shall not be lessened by any act of the said lessee.

11. The Lieutenant-Governor in Council may cancel this lease for non-payment of the rent hereby reserved as aforesaid within ninety days after the time the same is payable, whether the same has been demanded or not, or upon report by the said Hydro-Electric Power Commission that the conditions as to construction of the works or the development or supply of power have not been complied with or that at any time after the water privilege has been developed either in whole or to the extent to which the lessee bound or required to develop the same, the said lessee ha continuously failed or neglected for the space of one year effectually to produce power from the said privilege either for his or their own use or for that of other persons unless hindered by unavoidable accident, or that the lessee ha failed or neglected to comply with any of the conditions hereof or any Order in Council respecting any matter or thing arising hereunder concerning which such Order is made, and publication in the Ontario Gazette of any Order in Council cancelling this lease shall be sufficient proof that the same has been duly and lawfully cancelled. Provided that ten days' notice in writing shall be given the said lessee before any such cancellation in order that may have an opportunity of being heard should so desire.



Courtesy Hydro-Electric Power Commission

VIRGIN FALL, NIPIGON RIVER, ONT.

The acceptance of rent hereunder shall not be or be deemed to be a waiver of any of the terms or conditions herein expressed concerning the construction of works, development or supply of power or otherwise.

12. The said lessee shall not destroy or obstruct the navigation of the said River or any other river, stream, lake, or other body of water flowing into or out of the same, but shall provide such locks, canals, passages and other means as may be necessary for the proper and safe surmounting or passing of any dam, weir or other work made or erected by the said lessee and as may be required for purposes of navigation by the Government of Canada.

13. The said lessee shall not have the power or authority under these presents to overflow or cause to be overflowed any land or lands other than those hereby demised, and it is distinctly understood and agreed that should any lands other than those hereby demised be overflowed or damaged, the Crown or the Government of Ontario shall in no wise be responsible for damage done thereto to the owner or owners thereof.

14. The power and authority to acquire water-powers and works by purchase, lease or otherwise, or without the consent of the owners thereof conferred upon the said Power Commission by chapter fifteen of the Ontario Statutes of 1906 shall be exercisable by the said Power Commission in respect of the lands and water privilege hereby demised and any and all works connected therewith.

15. At the expiry or sooner determination of this lease the said lands hereby demised, together with the water-power or privilege aforesaid, shall revert to and become the property of Us, Our Heirs and Successors as fully as if these presents had never been executed, together with all buildings, dams, weirs, tunnels, races, flumes, sluices, pits and other structures and works situate thereon, provided nevertheless that within a reasonable time to be fixed by the said Power Commission the said lessee may remove all machinery employed by in the development or use of the said water-power or privilege, but failing such removal within the time so fixed, such machinery shall become the property of and be vested in Us, Our Heirs and Successors to all intents and purposes whatsoever. Provided that where any such buildings or structures are of a permanent character and necessary or useful for the proper development and utilization of the water privilege aforesaid, the Lieutenant-Governor in Council may upon report in that behalf by the said Hydro-Electric Power Commission, pay the lessee by way of compensation therefor and purchase thereof, such sum or sums as he may deem proper upon the same being appropriated for the purpose by the Legislative Assembly of the Province.

16. The Minister referred to herein shall be and include the Minister of Lands, Forests and Mines, or any Minister of the Crown performing the duties of the Minister of Lands, Forests and Mines in his absence or during a vacancy in that office; and the Minister may refer any and all matters and things arising under or by virtue of or in connection herewith to the Hydro-Electric Power Commission of Ontario for investigation, consideration and report.

Estimated H.P.	Development Required H.P.	Rental
2,860	500	First year, $1, second and third, $50. Then 25c. per H.P., minimum payment, $125.
4,500	2,500	First and second years, $1; third year, $100; fourth, $200; fifth, $300; sixth, $400; seventh, $600; eighth, $800; ninth, $1,000. Then 25c. per H.P., minimum payment, $1,000.
2,500	500	First year, $5. Then 25c per H.P., minimum payment $250.
4,100	1,500	First and second years, $10. Then 12½c. per H.P.; minimum, third year, $187.50; minimum, $312.50 thereafter.
1,887	1,300	First and second years, $10. Then 75c. per H.P.; minimum payment, $1,300.
430	No conditions.	$10 per annum.
2,360	1,500	First and second years, $10; third year, $100; fourth year, $150; fifth year, $200; sixth year, $300. Then 25c. per H. P., minimum payment, $375.
6,500	1,000	First year, $10. Then 50c. per H.P., minimum payment, $500.
1,320	500	First and second years, $10. Then 50c. per H.P., minimum payment, $250.
276 (theoretic)	300	$1.12½ per H.P. per annum; minimum payment, $337.50.
1,180	1,000	First year, $10. Then 50c. per H.P., minimum payment, $500.
2,020	800	12½c. per H.P. per annum; minimum payment, $100.
4,000 to 5,000	2,000	First and second years, $10; then not less than $1,000 per annum.
2,750	1,500	First and second years, $10; then not less than $750 per annum.
2,648	2,000	First and second years, $10. Then 50c. per H.P., minimum payment, $1,000.
Normal, 527 Min., 255	100	First year, $5. Then 50c. per H.P., minimum payment, $50.
3,200	2,000	First and second years, $10. Then 50c. per H.P., minimum payment, $1,000.
2,000 natural 2,500 with dam	2,000	First and second years, $10. Then 50c. per H.P., minimum payment $1,000.
4,170	3,000	First year, $10. Then 50c. per H.P., minimum payment, $1,500.
1,000	600	First and second years, $10. Then 50c. per H.P., minimum payment, $300.
3,287	2,000	First and second years, $10. Then 50c. per H.P., minimum payment, $1,000.
.....	100	First year, $25; then 25c. per H.P., minimum $25.
150	150	First year, $5; then 50c. per H.P., minimum $75.
7,000	2,000	First year, $10; then 50c. per H.P., minimum $1,000.

Powers Granted Many leases have been granted for water-powers and upon various terms and conditions. Several leases, also, which had been granted were afterwards cancelled. The rights and privileges disposed of since 1898 and upon record are set forth in the accompanying table, "Water-Power Leases in Force."

Later Enactments The present policy of the Ontario Government with respect to water-powers is more fully expressed in the later Acts under which the Hydro-Electric Power Commission is constituted and carries on its work.

These have been enacted chiefly as a result of the expressed desire on the part of the people of Ontario, that electric light and power be supplied the consumer at less cost than such were being supplied, or were likely to be supplied, by large corporations controlling the sources of hydro-electric energy. Since, therefore, the policy of the Government of Ontario for the conservation of the water-powers of the Province is intimately associated with the statutes relating to the Hydro-Electric Power Commission, it will be advisable to indicate the incidents which assisted in determining the laws of Ontario relating to water-power developments.

Ontario's later hydro-electric policy* has been prompted chiefly by events connected with the development at Niagara Falls, and, much of the earlier history of the hydro-electric legislation of the Province is found in the official records of the City Council of Toronto, the Union of Canadian Municipalities, the Western Ontario Municipal Niagara Power Union and the Niagara Power Union.

Early Agitation by Toronto City Council The City Council of Toronto has been active in the agitation for cheap light and power. In 1894, it recommended that tenders for a civic electric light plant be called for, but on June 1, 1895, a by-law for the establishment of this plant was defeated. In 1897, it passed a resolution calling for estimates of the cost of a civic plant to supply light and power to the city, and to the manufacturers of Toronto. Following this, a motion was made, Nov. 15, 1897, that tenders be called for the supply of power by parties having same for sale, "each tender to state whether the power to be delivered is to be generated or developed from steam, water-power, coal or other artificial or natural primary power or fuel, and if water-power, from what source."

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* The statements herein made are based upon the various reports issued by the several commissions and other organizations to whom reference is here made, while some of the facts have been gathered from the unpublished minutes of the Berlin conference, etc. For list of various reports see Appendices under *Bibliography*. See also *The Canadian Annual Review*.

On January 24, 1898, a special committee of the Council was appointed "to consider and report on the cost of an electric plant for lighting the streets and public buildings of the City, and also for the purpose of supplying electric energy to manufacturers and others requiring the same"; and on October 3rd of the same year a resolution of council was carried requesting the Committee on Legislation "to consider the advisability of obtaining power from the Local Legislature to enable the city to enter into the business of supplying electric energy to the citizens for commercial purposes." On January 23, 1899, the Council adopted the report of the Committee on Legislation and Reception, recommending that application be made to the Ontario Legislature "to enable the City to enter into the business of supplying electric energy to the citizens for commercial purposes."

On February 19, 1900, Council adopted the report of the Committee on Legislation and Reception, recommending that application be made at the next session of the Ontario Legislature.

> "To empower the City to purchase, develop or produce electric energy at any place not more than one hundred miles distant from the said City, and to secure any right of way and establish any poles, wires or other plant, or appliances, necessary to bring such energy to Toronto and there distribute it, and to raise loans and borrow moneys on debentures issued on the credit of the City and for the purpose of carrying out the said undertaking, and any other powers necessary to enable the Corporation of the City of Toronto to acquire, bring to Toronto and distribute electrical energy from any point within the distance aforesaid."

The Toronto Board of Trade

On February 19, 1900, the Council of the Toronto Board of Trade appointed a committee, consisting of Messrs. W. E. H. Massey, (chairman), Elias Rogers, Wm. Stone and A. E. Kemp, to "Report as to Electric Power." The Committee in its report of April 25, 1900, deals with the power situation so far as Toronto is concerned, and directs serious attention to the feasibility of Toronto's receiving electric energy from Niagara Falls. It also raises the question as to "whether or not Toronto as a city, should control this proposed Niagara power connection."

On December 13, 1900, another special committee of the Toronto City Council was appointed "to enquire and report upon the cost of installing a plant, and the steps necessary to secure the same." On June 17, 1901, notice was given of a proposed motion that "the proper officer communicate with the Niagara Power Company, with a view to getting full information regarding the terms upon which the said Company propose supplying electric energy to manufacturers and others in this City," and on January 13, 1902, a similar notice was given relating to power from Niagara Falls. On April 21, 1902, resolutions were carried by Council authorizing

communication to be made with the Niagara Power Company, and other companies, with a view to securing cheaper energy for the various users of light, heat and power.

Union of Canadian Municipalities

During 1901 and 1902, public sentiment had also been forming elsewhere throughout the Province. Manufacturers Associations, Boards of Trade and other organizations held meetings and passed resolutions. It was conceived that municipal corporations by combining, might better direct and secure the legislation they desired. Consequently, on August 16, 1901, a circular letter was sent to the municipalities of the Dominion by O. A. Howland, then Mayor of Toronto. The letter stated that

> "The primary object of the conference will be to arrange for a municipal union for common action in defence of municipal rights and the interests of citizens against the encroachments of great corporations, through Parliament, the Legislature, and otherwise."

The Convention called by Mayor Howland's letter met in Toronto on August 28–30, 1901, and the Union of Canadian Municipalities was formed.

Toronto's Committee on Legislation and Reception

The next forward step in the movement bears the date of Jan. 21, 1902, when the Committee on Legislation and Reception of the Toronto City Council, recommended in their Report No. 1

> "That the City Solicitor be instructed to immediately make application to the Provincial Legislature for the enactment of legislation empowering the Municipal Corporation of the City of Toronto to purchase electric energy at any place, and to secure any right of way and to establish any poles, wires or any other plant or appliances necessary to bring such energy to Toronto and there distribute it; and to raise loans and borrow moneys on debentures issued on the credit of the City for the purpose of carrying out the said undertaking, and any other found necessary to enable the Corporation of the City of Toronto to acquire, bring to Toronto and distribute electric energy from any point."

On January 27, 1902, a special committee was appointed

> "To assist the City Solicitor in his efforts to secure legislation to empower this Corporation to purchase and distribute electric energy, in accordance with the recommendation embodied in Report No. 1, of the Committee on Legislation and Reception adopted by Council this day."

Manufacturers Meet at Berlin

On June 9, 1902, representative manufacturers from towns and cities in Western Ontario met at Berlin to consider the best method whereby power could be secured from Niagara falls, at reasonable rates. Alderman Spence of Toronto, suggested to the conference

"That the municipalities should ask for the appointment of a Government commission, which would have the power to arrange for the transmission of electricity to the various municipalities desiring it. This commission would issue its own bonds in payment of the transmission lines, these bonds to be covered by the bonds of the various municipalities interested, the latter to be deposited with the commission. The amount of the bonds, of course, would depend upon the power required by the various municipalities. Under this scheme the Government through a commission would undertake the transmission of electrical energy from Niagara Falls, or any other point, to the municipalities desiring the power, the latter guaranteeing by their bonds the cost, and selling in turn to all manufacturers at an even rate, preventing in this way the power from falling into the hands of any monopoly and securing to the industries of the Province the advantage of cheap electrical energy."

It was then moved that "a special committee be appointed by this meeting, with power to add to its numbers, to prepare a co-operative plan for the securing of a supply of electrical power for manufacturing interests on the most favourable terms possible, the committee to call a convention of representatives appointed by municipal councils, Boards of Trade and Manufacturers Associations, to consider such plans and to take such steps to carry out any project agreed upon."

In accordance with this motion a Committee on Niagara Power was appointed.

On June 30, 1902, representatives from municipalities again met at Berlin and appointed a committee to interview the Ontario Government respecting the supplying of Niagara power to Western Ontario. On Oct. 20, 1902, at Galt, the committee reported and the minutes of that meeting state that

"The general opinion of the meeting was that it was unlikely that the Ontario Government would undertake the development and transmission of electrical power."

The committee then appointed a sub-committee consisting of Messrs. E. W. B. Snider and D. B. Detweiler to continue the investigation respecting the amount of power used in Western Ontario within a radius of 125 miles of Niagara Falls and the probable cost of transmitting the same.

On Dec. 15, 1902, the City Council of Toronto instructed the City Solicitor, in co-operation with the previously mentioned Committee on Legislation and Reception,

"To again make application at the ensuing session of the Provincial Legislature for the enactment of legislation empowering the City of Toronto to generate or develop electricity by means of water-power or otherwise, or to purchase electric energy at any place, and for such purposes to have all necessary powers for purchasing, leasing or

expropriating water-powers and lands in connection therewith, and for building and erecting the necessary buildings, plant and machinery for the purpose of such development, and to secure any right of way and establish any poles, wires or any other plant or appliances necessary to bring such electricity to Toronto and there distribute it, and to raise loans and borrow moneys on debentures issued on credit of the City for the purpose of carrying out the said undertaking, and any other powers necessary to enable the Corporation of the City of Toronto to generate, develop or acquire such electricity, and to bring it to Toronto and distribute it from any point, and that the Law Department co-operate with the Union of Canadian Municipalities in obtaining general municipal powers to this end."

At the first meeting of the new council, on Jan. 12, 1903, the Committee on Legislation and Reception were again requested to deal with the subject of securing legislation relating to the transmission of Niagara power to Toronto. Consequently on Jan. 19th, this committee, in their Report No. 1, recommended that application be made to the Ontario Legislature

"To empower the City of Toronto, or other Municipalities generally, to generate, develop or acquire electricity by means of water-power or otherwise, or to purchase electric energy at any place and for such purpose to have all necessary powers for purchasing, leasing or expropriating water-power and lands in connection therewith, and for buildings and erecting buildings, plant and machinery, and to secure the right of way, and establish any poles, wires or other plant, and to raise loans and borrow money, and any other powers necessary to enable the City of Toronto or other Municipalities to generate, develop or acquire electricity, and to bring it to Toronto or such other Municipality, and sell and distribute it from any point."

Special Committee *re* Electric Energy

On Jan. 12, 1903, the City Council of Toronto also adopted a motion that a special committee known as the Special Committee *re* Electric Energy

"Be appointed to consider and report to the Council at the earliest possible date what steps ought to be taken to secure for the City of Toronto, on the most favourable terms, a supply of electrical energy from Niagara Falls, or elsewhere, and to confer with other bodies, or committees, and to recommend any application for legislation or other action which they may deem desirable to promote the said object."

This Special Committee, in their Report No. 1, made an important recommendation which council adopted on Jan. 26, 1903. The report as adopted states, that

"Your Committee recommend that the Legal Department be instructed to give immediate notice on behalf of the City of application for legislation authorizing the City of Toronto to develop, purchase, transmit, distribute and sell electrical energy, either directly by compressed air or otherwise, and that the said Department draft and

submit to this Committee a Bill authorizing the City to exercise any or all of the said powers, and to take any action necessary thereto.

"Your Committee also recommend that in view of the fact that application may be made to the Dominion Parliament and Ontario Legislature at their coming sessions for permission to generate electricity at Niagara Falls and to transmit and sell the same for heat, light and power purposes, be it resolved that steps be taken to watch all such applications with a view to protecting the rights of all municipalities interested, and that if any agreements be entered into, a clause or clauses be embodied therein securing all municipalities from any monopoly in respect thereto."

Application was accordingly made to the Ontario Legislature, but the legislation was refused, as the Government had introduced a bill upon the same subject.

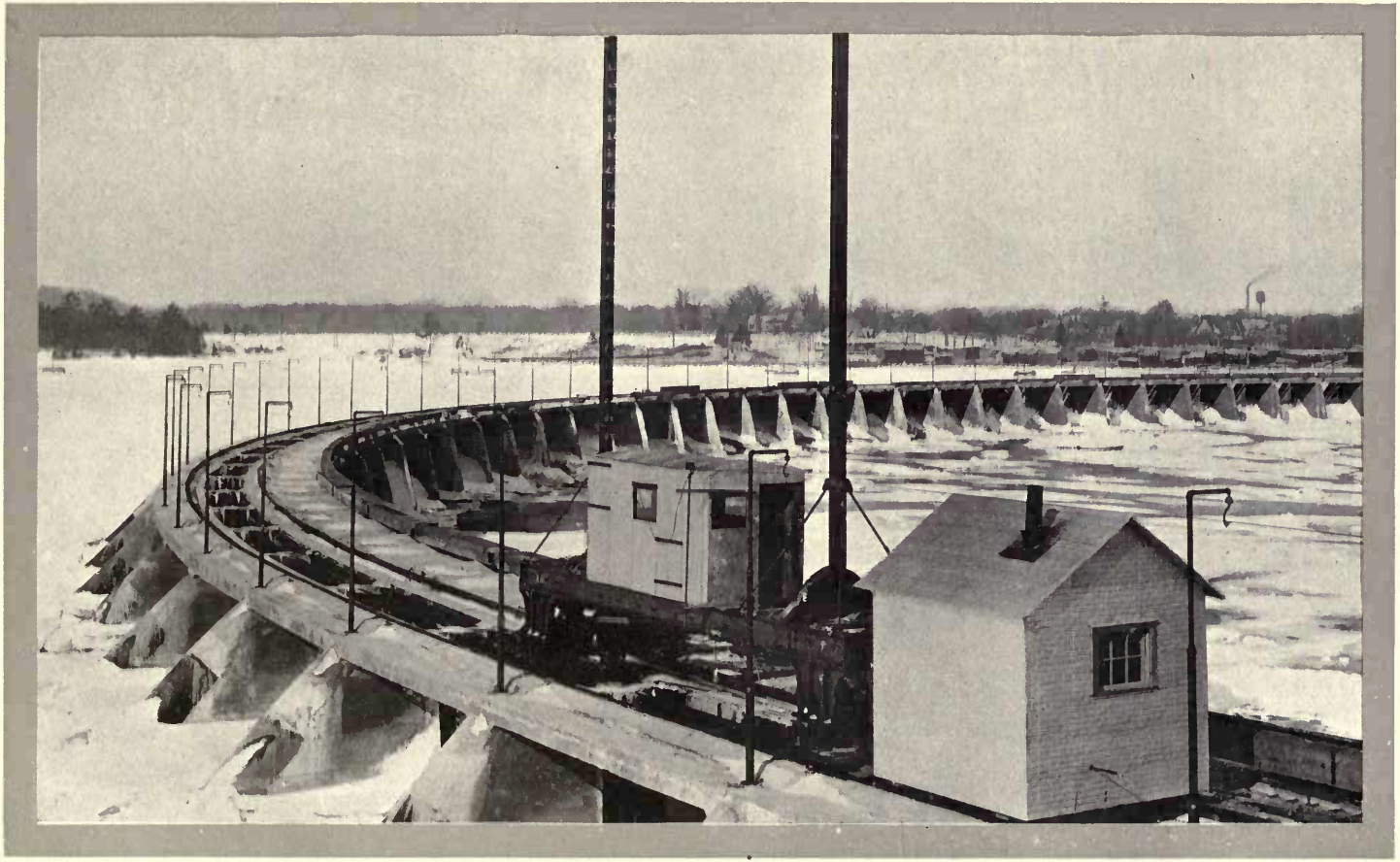
Committee of Western Ontario Manufacturers

Meantime, important meetings in the interests of securing cheap hydro-electric power were being held in other parts of the Province. On Feb. 12, 1903, the Special Committee *re* Electric Energy of the Toronto City Council, in their Report No. 2, stated that a communication had been received from a committee of Western Ontario manufacturers, asking that delegates be sent to a meeting of all municipalities interested in Niagara power, to be held in Berlin, on Feb. 17, 1903. At this meeting, at which about 80 representatives of municipalities, of manufacturers, and of Boards of Trade were present, the report of the sub-committee was adopted. The report, dated Feb. 16, 1903, in part, states, that

"To enable municipalities to so develop or purchase and sell or otherwise distribute electrical power, legislation would of course be necessary, and we recommend that prompt action be taken towards securing from the Legislature at the approaching session the necessary power enabling municipalities to undertake such work. Such legislation should empower municipalities to co-operate when authorized by vote of the property-owners of the respective municipalities, to develop and transmit, or distribute electrical energy; or to buy and transmit such power; or to buy power delivered at the several municipalities, and to sell and distribute the same within their own limits."

Subsequent to the adoption of the report, the following resolution, moved by Mayor Urquhart of Toronto, and seconded by Mayor Adam Beck of London, was carried:

"Therefore be it resolved that we respectfully suggest to and urge upon the Government of the Province of Ontario the advisability of the Government building and operating as a government work, lines for the transmission of electricity from Niagara Falls to the towns and cities, and that the municipalities here represented call upon their representatives in the Legislative Assembly of Ontario to urge upon the Government to carry out this resolution."



CHAUDIERE REGULATING DAM, OTTAWA RIVER, OTTAWA

In accordance with this resolution, a committee was appointed to wait upon the Ontario Government, and ascertain if it would undertake the transmission of power, failing which a plan for municipal co-operation was to be prepared and submitted to the Government.

Deputation to the Government

On Feb. 27, 1903, a deputation, representing the principal municipalities of Western Ontario, waited upon the Ontario Government and presented a memorandum embracing the resolutions passed at the Berlin meeting of Feb. 17. Premier Ross stated, in addressing the deputation, that a Government Bill would be introduced with the object of providing the means by which the municipalities would be able to arrange for the development, transmission, distribution and sale of electric energy. The Premier suggested that the work might be carried on through the agency of a commission appointed by the municipalities.

Legislation for Municipal Action

In accordance with this promise, an Act * was passed on the 12th of June 1903, intituled "An Act to provide for the Construction of Municipal Power Works and the Transmission, Distribution and Supply of Electrical and other Power and Energy." It enjoins conformity to many of the regulations set forth in the Municipal Act, and in the Railway Act of Ontario. It empowers any municipal corporation, or any two or more municipal corporations jointly, to appoint commissioners through whom full investigations may be made as to the feasibility of acquiring, constructing, and operating such works as might be proposed for supplying the municipalities interested with electrical or other energy. Provision is made for the appointment by the Commission of such officers and assistants as they may require, and for the raising of funds by municipalities for the construction of such works. The Board of Commissioners is also authorized to enter into contracts, issue bonds, determine the rates of rental or other disposal of power, collect rents and exercise many very important and far-reaching powers in the sphere of both practical engineering and of finance. Any Commission appointed under the Act was denied exercise of the powers of expropriation in so far as Queen Victoria Niagara Falls Park, and its future extensions, was concerned, unless the consent of the Park Commissioners was obtained.

The Ontario Power Commission

After this Act (3 Ed. VII, chap. 25) was passed, representatives from municipalities interested in securing Niagara power, met at the City Hall, Toronto, on Aug. 12, 1903, and passed the following resolution:

> "That this meeting recommends the appointment, by the municipalities which desire to co-operate under the Act to provide for the construction of Municipal Power Works, etc., of E. W. B. Snider, P.W.

* 3 Ed. VII, chap. 25.

> Ellis, Adam Beck and W. F. Cockshutt, and such electrical engineer as they may select to act with them, and shall recommend to the municipalities for that purpose, as commissioners under Section 2 of the said Act, to express the powers and perform the duties defined by Section 3, and following Sections of the Act, for the information and benefit of the municipalities so desiring to co-operate; and to report as provided by the Act to the municipalities joining in their appointment."

On Dec. 10, 1903, this Committee wrote to the city of Toronto, urging the completion of the Commission so that it might enter upon its practical investigations. An estimate of the cost of the investigation was given, based upon the assessment of each of the seven municipalities that had decided to appoint the Commission. The estimate was $88.23 per million dollars of assessment on an aggregate assessment of $170,000,000.00. The Special Committe *re* Electric Energy in their Report No. 5, adopted in Council, Dec. 23, 1903, recommended that the municipality of Toronto and the other municipalities interested enter into an agreement with the Commissioners.

Subsequently, the municipalities of Toronto, London, Brantford, Stratford, Woodstock, Ingersoll and Guelph appointed a Commission, known as the Ontario Power Commission, consisting of Messrs. E. W. B. Snider, P. W. Ellis, W. F. Cockshutt, Hon. Adam Beck, and R. A. Fessenden, an electrical engineer, who was the technical member of the Commission. Messrs. Ross and Holgate, consulting engineers of Montreal, were deputed by the Commission to investigate and report upon the engineering aspects of the whole power situation in Western Ontario.

A Declaration of Policy

While the Ontario Power Commission was carrying on its investigations, an election was held which resulted in a change in the Government of the Province. The new Government expressed itself as being in favour of conserving the water-powers of the Province. On April 19, 1905, Premier Whitney said:

> "The water-power at Niagara should be as free as air, and, more than that, I say on behalf of the Government, that the water-powers all over this country shall not in future be made the sport and prey of capitalists, and shall not be treated as anything else but a valuable asset of the people of Ontario, whose trustees the Government of this people are."

Commission of Enquiry

One of the early acts of the new Government was the appointment on July 5, 1905, of a Commission of Enquiry to report regarding hydraulic and electric power in the province of Ontario. The Commission consisted of Hon. Adam Beck, George Pattinson and P. W. Ellis. Subsequently, owing to ill-health, Mr. Ellis resigned and John Milne was appointed in his stead. This new personnel, constituted

a second Commission of Enquiry with wider powers than the first Commission.*

The Commission besides being assigned other duties, was required to ascertain:

1. The present and probable demand for hydraulic and electrical power in the various districts capable of being supplied from the different water-powers within the jurisdiction of the Province of Ontario.

2. The location, capacity and capital cost of development of the various water-powers within the legislative jurisdiction of the Province of Ontario at present undeveloped, but whose development is required to supply the present and probable needs of the surrounding districts, and to ascertain the cost of the attendant transmission plant necessary to the utilization of electrical and hydraulic powers to be provided from the aforesaid water powers within the respective surrounding districts.

3. The rates or prices that would require to be charged the various classes of consumers of hydraulic or electrical power within the respective districts in order to meet all expenditure of maintenance and operation.

4. The annual savings accruing to the consumers in the various districts aforesaid by the substitution of the rates or prices in the next preceding paragraph for the rates paid at present in the said districts so far as the Commissioners may be able to ascertain or estimate them.

5. The cash capital cost of the hydraulic and electrical power undertakings of existing companies located within the Province of Ontario; the capacity and state of development thereof.

The findings of the Commission are recorded in five reports, the first of which was published April 4, 1906. The Ontario Power Commission had already reported on March 28, 1906, in an able and comprehensive document, subsequently published, entitled "Official Report of the Ontario Power Commission."

Union of Municipalities of Western Ontario

The Report of the Ontario Power Commission, and the First Report of the Hydro-Electric Power Commission, convinced the municipalities that hydro-electric power could be distributed and sold at much less cost than was then being done. It was decided to unite the municipalities of Western Ontario in an organization corresponding somewhat to the Union of Canadian Municipalities and, accordingly, on March 23, 1906, about sixty representatives

* For full text of Orders in Council relating to Commissions of Enquiry, consult *Records of Office of the Executive Council*, Liber II, No. 1 and Liber II, No. 5.

of the municipalities more immediately concerned with the power problem, met at Galt. The following resolution was passed:

> "That, whereas power from the Niagara Falls is natural wealth, and as such should be enjoyed by the largest possible number; and whereas cheap power is essential to the success of factories and industries of almost any kind, particularly in Ontario where coal is expensive; and whereas experience has shown that this great national and natural asset would be practically worthless if controlled by private companies; and whereas there is in our opinion no regulation sufficiently effective whereby power can be obtained from the owners of existing franchises at reasonable rates; Therefore be it resolved, that this gathering of municipalities urgently desire and respectfully ask the Government of Ontario to at once themselves establish a power plant at Niagara Falls, or secure the power produced under existing franchises for distribution to reachable municipalities of Ontario."

Further Legislation is Required

Meantime in the early part of 1906, Hon. Mr. Beck visited various municipalities in Western Ontario making addresses in favour of cheaper power and outlining the power policy of the Government.

On April 11, 1906, representatives of Windsor, Sarnia, Guelph, Berlin, Woodstock, St. Thomas, London, Kingston, Galt, Stratford and some thirty other towns and municipalities were received by Premier Whitney and his colleagues. The Toronto Board of Trade, the Canadian Manufacturers Association, the Retail Merchants Association and others were also represented. A preliminary meeting was held, at which the following resolution was unanimously passed:

> "That the municipalities now present and represented in the City Hall, Toronto, having an urban and rural population of over 1,000,000, respectively urge upon the Governor in Council of the Province of Ontario the necessity of safe-guarding the peoples interests by originating as a Government measure legislation enabling the Governor in Council to appoint a permanent Provincial Commission with power to take, where considered by it advisable, the following action: The construction, purchase or expropriation of works for the generation, transmission, and distribution of electric power or light; to arrange with any existing development company, or companies, for power at a reasonable price, so as to be transmitted and sold by the Government to municipalities or others; also to vest in it the powers necessary to enable it to regulate the price at which electricity shall be sold to all and every consumer whether municipal, corporate, or private."

A deputation then presented this resolution to the Government and, as a result, assent was given on May 14, 1906, to "An Act to provide for the Transmission of Electrical Power to Municipalities."* This act pro-

* 6 Ed. VII, chap. 15.

vides for the appointment by the Lieutenant-Governor in Council of a commission, to be known by the name of "The Hydro-Electric Power Commission of Ontario" and, under it

> "Any municipal corporation may apply to the Commission for the transmission to such corporation of electrical power or energy for the uses of the corporation and the inhabitants thereof, for lighting, heating and power purposes, and the Commission may thereupon furnish to such municipal corporation estimates of the cost of constructing, erecting, installing and maintaining all such buildings, works, plant, machinery, poles, wires, conduits and other structures as may be necessary for the purpose of supplying the amount of electrical power or energy required by such municipal corporation and may also furnish to such corporation plans and specifications of the works, plant, machinery and appliances, necessary for the distribution of such power and energy by such municipal corporation, together with an estimate of the cost thereof. The Commission shall further furnish to such municipal corporation a statement of the terms and conditions upon which such electrical power or energy may be transmitted and supplied, together with a form of the contract to be entered into between such municipal corporation and the Commission."

The Act provides for the raising of moneys for the work, allows the Commission to enter into contracts, and gives it wide powers of expropriation. It provides that any municipal corporation may apply to the Commission for electrical energy for the uses of the corporation and the inhabitants, and the Commission is authorized to supply information as to estimated cost of labour and material for an equipment, and of the energy itself, together with plans and specifications for the necessary equipment.

Hydro-Electric Power Commission

On June 7, 1906, the Hydro-Electric Power Commission of Ontario was appointed by Order in Council, and given the full powers conferred by the enabling Act. This Commission consisted of Hon. Adam Beck of London, Hon. John S. Hendrie of Hamilton and Cecil B. Smith of Toronto. Subsequently Mr. Smith resigned, and on Feb. 28, 1907, William K. McNaught of Toronto, was appointed in his place. Messrs. Beck, Hendrie and McNaught are the Commissioners at the present time (1911). P. W. Sothman is chief engineer and R. A. Ross, consulting engineer.

The Niagara Power Union

Consequent upon the passing of this Act,* the Western Ontario Municipal Niagara Power Union met at Galt, July 24, 1906, and passed a resolution stating,

> "That the municipalities here represented decide to co-operate in order to avail themselves of the benefits of the Act passed at the last session of the Legislature of the Province of Ontario, being an Act to

* 6 Ed. VII, chap. 15.

provide for the purchase and transmission of electric power to municipalities, and for that purpose be it resolved that each municipality here represented, and such others as may from time to time join, do furnish to the executive committee as soon as possible an estimate of the amount of power it will require under the Act, or will use for public lighting, heating and power purposes; and also for manufacturing and other purposes; and that the executive committee be authorized to take all necessary steps to procure from the Hydro-Electric Power Commission of Ontario estimates of the various items of cost and other particulars under Section 6 of the Act, and to lay before the municipal councils full information as to the same so as to enable the councils to submit to their electors by-laws to authorize them to enter into contracts with the Commission for the transmission of electric power, under the terms of the Act."

This Union, afterwards called the Niagara Power Union, was an organization which represented the various municipal bodies of Western Ontario in a manner somewhat corresponding to that in which the Hydro-Electric Power Commission represented the Ontario Government.

New Powers Given the Commission

On Nov. 22, 1906, the Hydro-Electric Power Commission reported that 46 municipalities had applied for 124,075 H.P., of which 113,575 H.P. were required within the Niagara district. On December 5, 1906, a conference of municipal delegates met representatives of the Hydro-Electric Commission at Berlin, and passed a resolution unanimously endorsing the work of the Commission. In January, 1907, Toronto, by popular vote, carried a by-law authorizing the city to contract for electric energy from the Hydro-Electric Power Commission, and by-laws of a similar nature were passed by Toronto Junction, Ottawa, Hamilton, Galt, London, Ingersoll, New Hamburg, Woodstock, Stratford, St. Marys, Weston, St. Thomas, Preston, Paris and Waterloo. As a result, the Government promoted the passage of "An Act to Provide for the Transmission of Electrical Power to Municipalities."* It repeals 6 Ed. VII, chap. 15, and, in its main provisions, follows the general lines of the Act repealed. It gives greater scope to the Commission, and defines its powers more clearly. Its scope is set forth in sections 8 and 14, which are as follows:—

SECTION 8.—The Lieutenant-Governor in Council, upon the report of the Commission recommending the same, may authorize the Commission:

(a) To acquire by purchase, lease or otherwise, or without the consent of the owners thereof or persons interested therein to enter upon, take and use the lands, waters, water privileges, water powers, works, machinery and plant of any corporation or person owning, holding under lease or otherwise or developing, operating or using the same for generating or adapted for generating electrical power or energy or for the transmission thereof in Ontario, and to develop and use the same for any of the purposes of this Act;

*7 Edward VII, chapter 19.

(b) To construct, maintain and operate, and to acquire by purchase, lease or otherwise, or without the consent of the owners thereof or persons interested therein to enter upon, take, and use, all erections, machinery, plant, and other works and appliances for the transmission and supply of electrical power or energy, and to conduct, store, transmit and supply electrical power or energy for the purposes of this Act and with lines of wires, poles, conduits, motors or other conductors or devices to receive, conduct, convey, transmit, distribute, supply or furnish such electrical power or energy to or from any corporation or person at any place, through, over, under, along or across any lands, public highway, bridge, viaduct, railway, waters or water courses, and through, over or under the lands of any corporation or persons and to enter upon any lands upon either side of such lines or conduits and fell or remove any trees or limb thereof, or obstruction, which in the opinion of the Commission, it is necessary to fell or remove;

(c) To contract with any corporation or person generating, transmitting or distributing electrical power or energy or proposing so to do to supply electrical power or energy to the Commission; and to require any corporation or person generating, transmitting or distributing electrical power or energy to supply so much thereof as the Commission may require.

SECTION 12.—Any municipal corporation may apply to the Commission for the transmission and supply to the corporation of electrical power or energy for the use of the corporation and the inhabitants of the municipality for lighting, heating and power purposes or for any or either of such purposes or for any of the purposes mentioned in section 14, and the Commission shall thereupon furnish to the corporation a statement of the maximum price per horse power at which the electrical power or energy will be supplied at the point of development or of its delivery to the Commission and an estimate of the cost of constructing or providing a transmission line by means of which the amount of electrical power or energy required by the corporation is to be supplied and of maintaining the same, and may furnish to the corporation plans and specifications of the works, plant, machinery and appliances necessary for the distribution of such power or energy by the corporation and an estimate of the cost thereof, and such other information as the Commission may deem advisable. The Council may thereupon enter into a provisional contract with the Commission for the supply of electrical power or energy for the purposes mentioned in the Act.

Power Commission Amendment Acts

Many municipalities had already passed by-laws authorizing their respective councils to contract with the Hydro-Electric Commission; and the Commission itself had entered into agreements with the Ontario Power Company of Niagara Falls for the supply of power. On April 14, 1908, the Ontario Government passed an Act intituled "An Act to Validate certain By-laws passed and contracts made pursuant to 'An Act to Provide for the Transmission of Electrical Power to Municipalities.'" By this Act,* in which the contracts

*8 Ed. VII, chap. 22. Contracts with other municipalities are confirmed by 1 George V, chap. 16.

are set forth as schedules, the by-laws and contracts just referred to were validated.

Some of the municipalities who were entering into contracts with the Hydro-Electric Commission had encountered difficulties,* and, on March 29, 1909, the Government passed an act amending the "Act to provide for the Transmission of Electrical Power to Municipalities."† By it‡ various contract difficulties are removed; the powers of the Commission are further increased, and it is expressly enacted that any action which calls in question the jurisdiction of the Commission in various matters "shall be and the same is hereby forever stayed."

The Power Commission Act, 1911

In 1911 an Act was passed intituled "An Act to Provide for the Local Distribution of Electrical Power."** This is, essentially, an extension to small municipalities of the privileges embodied in the Power Commission Act, 7 Edward VII, chapter 19.

The Act, in referring to the corporation of a city, town, township or village municipality states, that

> "Any one or more of the ratepayers in a municipality, the corporation of which has not entered into a contract with the Commission under The Power Commission Act, may apply to the corporation to obtain from the Commission a supply of electrical power or energy for the use of such ratepayer or ratepayers for lighting, heating and power purposes or for any of such purposes."

and further,

> "The Corporation without submitting the same to a vote of the electors and without any of the other formalities required in the case of a By-law passed under The Power Commission Act, may pass a By-law for entering into a contract with The Commission for the supply of the electrical power or energy required by the applicants, and may enter into a contract with The Commission for that purpose."

Under this Act the trustees of a police village shall, for the purposes of the Power Commission Act, be deemed a municipal corporation.

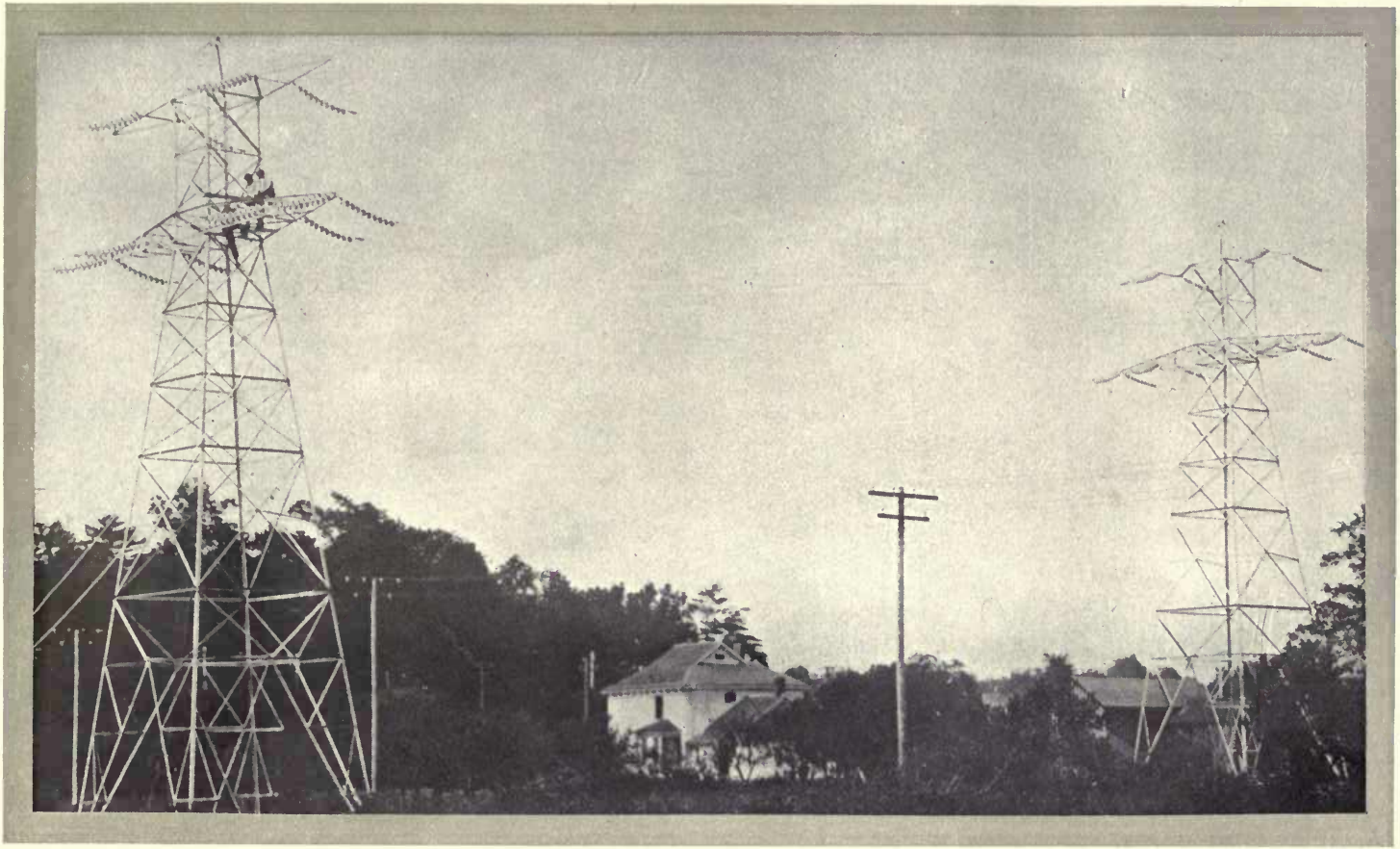
---

* One of the difficulties encountered by the Commission was an application made to the Federal Government to disallow the power legislation of Ontario. This petition was not granted. For a history of the question consult the *Bibliography*.

† 7 Ed. VII, chap. 19.

‡ 9 Ed. VII, chap. 19. By 10 Ed. VII, chap. 16, matters of a technical nature respecting questions of title, privilege, easement, inspection rights, by-laws, and the construction work of the Commission are dealt with.

** 1 George V, chap. 14.



HYDRO-ELECTRIC POWER TRANSMISSION LINE "A", SHOWING JOINT IN TOWER LOOP.

The Power Commission Amendment Act, 1911

In 1911, another Act was passed intituled "An Act to amend the Power Commission Act."* This Act grants the Hydro-Electric Power Commission of Ontario wide powers respecting the approval, inspection and other jurisdiction over the "wires, pipes, poles, conduits, ducts, and other fixtures, appliances or apparatus" of municipal and private corporations.

The exclusive character of this jurisdiction may be seen from clauses 6 and 7 of the Act which state, that

> 6. The Commission shall have exclusive jurisdiction as to all matters in respect of which authority is, by this Act, conferred upon it, and nothing done by the Commission within its jurisdiction shall be open to question or review in any action or proceeding or by any Court.
>
> 7. No Court shall have authority to grant, or shall grant an injunction, or other order, restraining either temporarily or otherwise, the construction, maintenance or operation of any works, the location and mode of construction of which have been approved by The Commission if the same are being, or have been, constructed in the place and according to the mode which have been so approved.

The Acts mentioned in the foregoing survey, taken in connection with the powers conferred upon the Hydro-Electric Power Commission as specified in the Regulations *re* Water-Powers of January 16, 1907, set forth the present status of Ontario's legislation relating to water-powers. The incidents associated with the hydro-electric development of Niagara Falls, and which led up to the establishment of the Hydro-Electric Power Commission, are a most important part of the industrial history of the province of Ontario.

The Work of the Hydro-Electric Power Commission

When the legislation had been provided allowing the Commission to transmit electrical energy, a number of municipalities in Western Ontario ascertained their respective power needs and then signified their readiness to negotiate with the Commission to supply them with specified amounts of power.

These representations, in turn, furnished a basis upon which the Commission could open negotiations with the large power producing companies at Niagara Falls. These companies were then asked to submit tenders for supplying electrical energy to the Commission. As a result the Commission entered into a contract† with the Ontario Power Company to

*1 George V, chap. 15.

† Agreements between the Commission and the Ontario Power Co., are published in *First Annual Report of the Hydro-Electric Power Commission*, pp. 57-70, Ontario *Sessional Papers*, No. 48, 1911. See, also, Ontario Statutes, 8 Ed. VII, chap. 22.

purchase not less than 8,000 H.P., and as much more electrical energy as was required, up to 100,000 H.P., for a term of ten years, with provision for three extensions for additional periods of ten years each. The price paid is $9.40 per H.P. per annum if the quantity taken exceeds 25,000 H.P. The prices cover a twenty-four hour continuous service and the power is to be delivered by the Company to the Commission at Niagara Falls at 12,000 volts.

Subsequent to the making of this contract, the Commission had furnished certain municipal corporations with estimates showing the probable costs of electrical energy delivered ready for distribution. The electors had assented to by-laws authorizing the municipalities to contract with the Commission for the delivery of the power they severally required. Accordingly, contracts with the Commission were made for the delivery of specified amounts of electrical horse-power.*

Construction of Transmission Lines

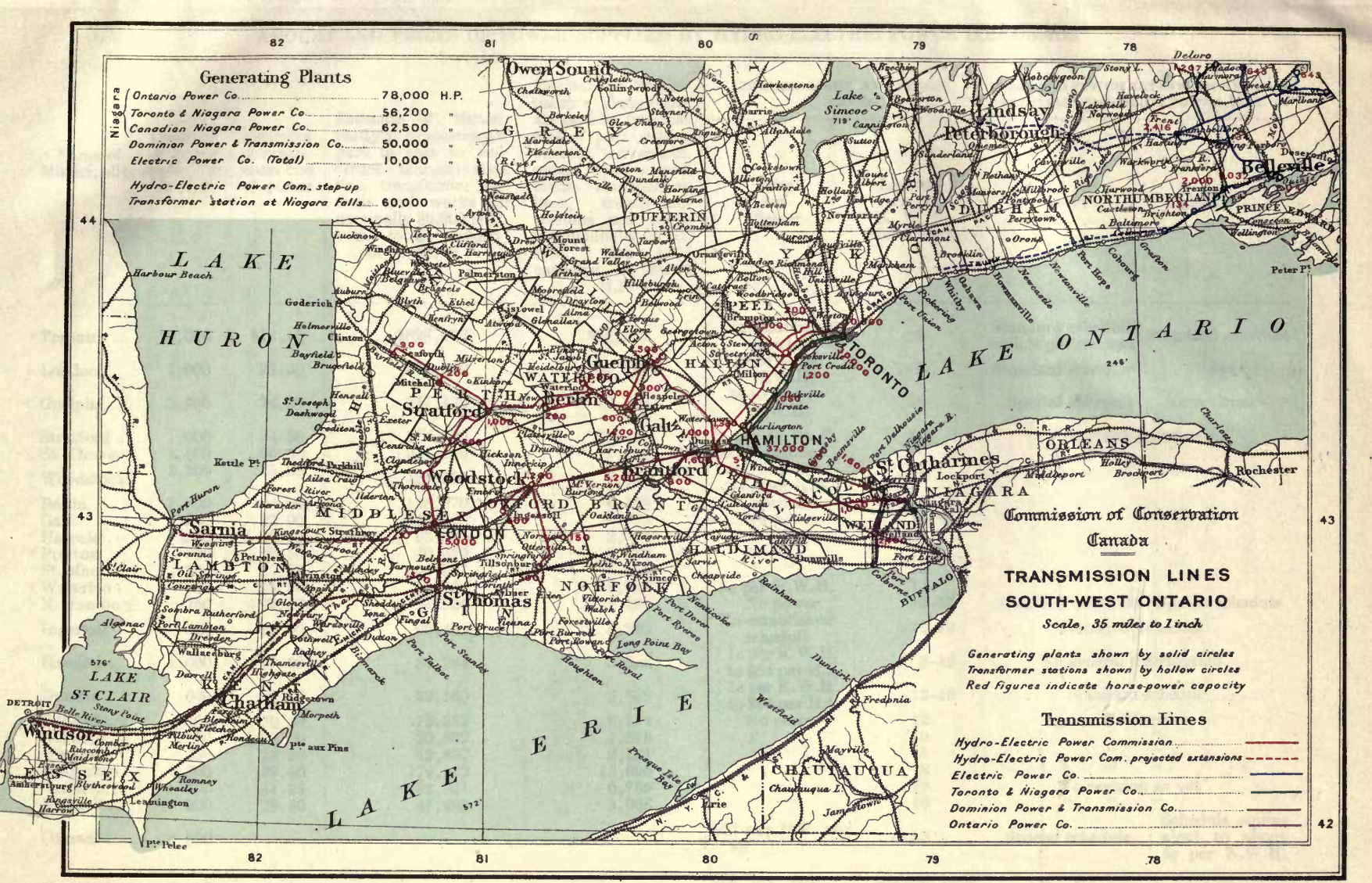
The delivery of this power demanded that a transmission line be built by the Commission. The construction of such a line was therefore undertaken, together with that of necessary transformer stations and other appurtenant works. The cost of construction and maintenance of the line is apportioned among the participating municipalities. This undertaking as originally planned is now virtually completed, and Niagara power is already being used by several municipalities. The total cost of the construction works undertaken by the Commission is about $3,500,000.

It is the purpose of the Commission to extend its activities to the whole of the province.† As yet, however, its construction operations have been confined simply to the Niagara peninsula and Western Ontario.

The physical project begins with a transformer station at Niagara Falls which takes the power on delivery at 12,000 volts. Thence, a 60,000 H.P., double transmission line operating at 110,000 volts conveys the current to a controlling station at Dundas, whence the line is continued east to the city of Toronto with a local transformer station at Port Credit. From the controlling station at Dundas a double line of the same capacity and voltage is continued *via* Woodstock and London to St. Thomas, with local transformer stations at these points. From the same central controlling station at Dundas a similar line proceeds north and

* See Schedule B, Ontario Statutes, 8 Ed. VII, chap. 22.

† It may be stated that the scope of the Commission's work has already been comprehensively reviewed in an address delivered by the Honourable Adam Beck, Chairman of the Hydro-Electric Power Commission before the First Annual Meeting of the Commission of Conservation; (See *First Annual Report*, pp. 91 *et seq.*) Some features of the work are also viewed in greater detail in the *First and Second Annual Reports of the Hydro-Electric Power Commission.* Statements from these reviews, as well as additional data furnished by Mr. Beck, have been freely used in the above survey.


Generating Plants
Ontario Power Co. 78,000 H.P.
Toronto & Niagara Power Co. 56,200 "
Canadian Niagara Power Co. 62,500 "
Dominion Power & Transmission Co. 50,000 "
Electric Power Co. (Total) 10,000 "
Hydro-Electric Power Com. step-up
Transformer station at Niagara Falls 60,000 "
Commission of Conservation
Canada
TRANSMISSION LINES
SOUTH-WEST ONTARIO
Scale, 35 miles to 1 inch
Generating plants shown by solid circles
Transformer stations shown by hollow circles
Red figures indicate horse-power capacity
Transmission Lines
Hydro-Electric Power Commission
Hydro-Electric Power Com. projected extensions
Electric Power Co.
Toronto & Niagara Power Co.
Dominion Power & Transmission Co.
Ontario Power Co.
LAKE HURON
LAKE ONTARIO
LAKE ERIE
LAKE ST CLAIR
Owen Sound
Lindsay
Peterborough
Belleville
Stratford
Guelph
Galt
Kitchener
Waterloo
Woodstock
Brantford
HAMILTON
St. Catharines
London
St. Thomas
Chatham
Windsor
Sarnia
TORONTO
Niagara Falls
Buffalo
Rochester
Detroit
Erie
Chautauqua
GREY
DUFFERIN
SIMCOE
YORK
PEEL
HALTON
WENTWORTH
LINCOLN
WELLAND
ORLEANS
NORTHUMBERLAND
DURHAM
PRINCE EDWARD
MIDDLESEX
OXFORD
BRANT
NORFOLK
HALDIMAND
LAMBTON
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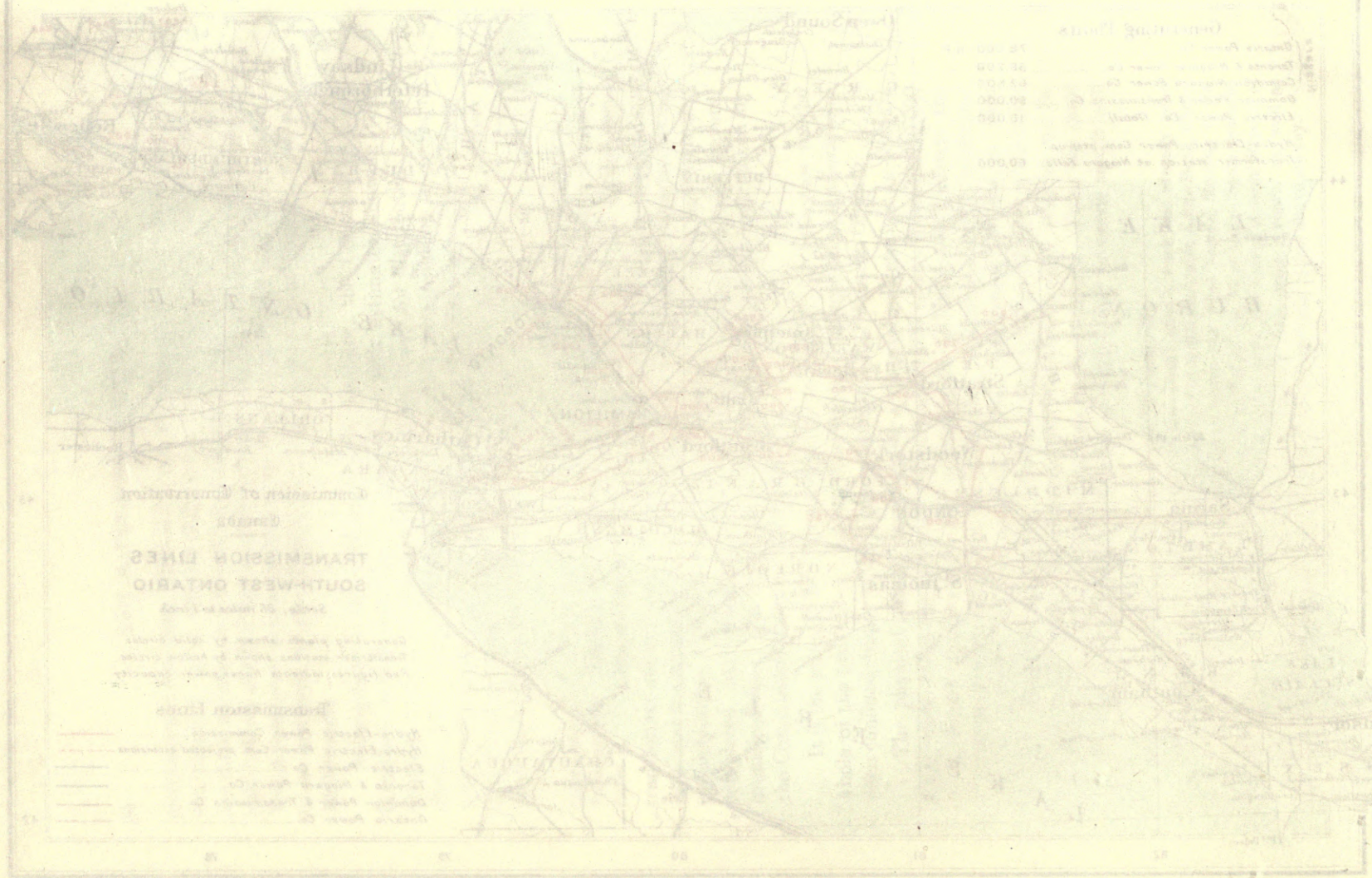

AMOUNT AND PRICES OF POWER SUPPLIED BY HYDRO-ELECTRIC POWER COMMISSION

Name of Municipality	Quantity of power applied for in H.P	Estimate of maximum cost of power	Estimate of Municipality's proportionate part of cost to construct transmission line, transformer stations and works for nominally 30,000 H.P., with total capacity of 60,000 H.P.	Estimate of Municipality's proportionate part of line loss and of part cost to operate, maintain, repair, renew and insure transmission lines, transformer stations and works for nominally 30,000 H.P., with total capacity of 60,000 H.P.	FORMER LIGHT AND POWER RATES		LIGHT AND POWER RATES WITH HYDRO-ELECTRIC COMMISSION POWER, 1911	
					Price for Power	Lighting; rate per K. W. H. (Net in cents)	Power	Lighting
Toronto. . .	10,000	$18.10	$828,080	$38,970	No established schedule	8	Standard schedule* with slight changes	Standard schedule
London. . .	5,000	23.50	671,080	31,578	4c to 8c per K.W.H.	9	Standard schedule	4½c
Guelph. . . .	2,500	24.00	347,420	16,350	3c to 5c per K.W.H.	10	Special schedule	No revision
Stratford . .	1,000	24.50	215,600	10,146	8c per K. W. H.	12	Standard schedule	
St. Thomas.	1,500	26.50	244,140	11,490	No schedule	10	"	"
Woodstock.	1,200	23,00	155,350	7,310	$60 flat or 3-6c per K.W.H	8	"	"
Berlin.	1,000	24.00	138,970	6,540	Special	6–7.6	..	..
Galt.	1,200	22.00	143,920	6,773	No power	10.8	..	..
Hespeler. . .	300	26.00	63,200	2,974	" "	10.8	..	..
Preston. . . .	600	23.50	80,530	3,789	" "	10	..	"
St. Marys . .	500	29.50	95,677	4,502	" "	10	..	"
Waterloo . .	685	24.50	98,460	4,630	8c per K.W.H.	12	"	"
N. Hamburg	250	29.50	47,830	2,251	No power	10–12	Standard schedule	Special schedule
Ingersoll. . .	500	24.00	69,485	3,270	No established schedule	10–12	Standard schedule	
Hamilton. . .	1,000	17.92	84,384	3,620	1c per K.W.H. to $84 per H.P.	8–12	No general distribution	
Dundas. . . .	600	17.33	32,160	2,892	1c per K.W.H. to $84 per H.P.	12–15	Standard schedule	
Tillsonburg.	500	30.50	75,387	6,174	No power	12	No revision	
Norwich. . . .	150	30.00	20,832	1,875	" "	10	" "	
Weston. . . .	250	29.25	42,437	2,501	" "	8	" "	
Brampton . .	1,300	29.40	179,132	15,690	" "	8	" "	
Seaforth. . . .	400	41.25	102,941	6,769	" "	12	No revision as yet	
Mitchell . . .	200	38.50	47,490	3,066	" "	10	" " " "	
Ottawa. . . .	4,500	.....	.....	.....	$40 per H.P. and up	15	Special schedule	Schedule equivalent to about 6c per K.W.H.
Port Arthur.	5,000	.....	.....	.....	$25 per H.P., connected	Special, both flat and meter	No revision as yet	

*For Standard Schedule, see p. 52.

Name of Municipality	Quantity of power applied for in H.P.	Estimate of maximum cost of power	Estimate of Municipality's proportionate part of cost to construct transmission lines, transformer stations and works for nominally 30,000 H.P., with total capacity of 60,000 H.P.	Estimate of Municipality's proportionate part of line loss and of part cost to operate, maintain, repair, renew and insure transmission lines, transformer stations and works for nominally 30,000 H.P., with total capacity of 60,000 H.P.	Former light and power rates: Price for Power	Former light and power rates: Lighting, rate per K. W. H. (Net in cents)	Light and power rates with hydro-electric commission power, 1911: Power	Light and power rates with hydro-electric commission power, 1911: Lighting
Toronto	10,000	$18.10	$828,080	$38,970	No established schedule	8	Standard schedule with slight changes	Standard schedule
London	5,000	23.50	674,080	31,578	4c to 8c per K.W.H.	9	Standard schedule	4½c
Guelph	2,500	24.00	347,420	16,330	3c to 5c per K.W.H.	10	Special schedule	No revision
Stratford	1,000	24.50	216,600	10,140	8c per K. W. H.	12	Standard schedule	
St. Thomas	1,500	26.50	244,140	11,490	No schedule	10	"	"
Woodstock	1,200	23.00	155,350	7,310	$60 flat or 3.6c per K.W.H.	8	"	"
Berlin	1,000	24.00	138,970	6,540	Special	6-7.5	"	"
Galt	1,200	23.00	148,220	6,773	No power	10.8	"	"
Hespeler	300	26.00	63,200	2,974	" "	10.8	"	"
Preston	600	23.50	80,530	3,789	" "	10	"	"
St. Marys	500	29.50	95,677	4,503	" "	10	"	"
Waterloo	685	24.50	98,460	4,630	8c per K.W.H.	12	"	"
N. Hamburg	250	29.50	47,830	2,251	No power	10-12	Standard schedule	Special schedule
Ingersoll	500	24.00	69,485	3,270	No established schedule	10-12	Standard schedule	
Hamilton	1,000	17.92	84,384	3,620	1c per K.W.H. to $84 per H.P.	8-12	No general distribution	
Dundas	600	17.93	32,160	2,892	1c per K.W.H. to $84 per H.P.	12-15	Standard schedule	
Tillsonburg	500	30.50	15,337	6,174	No power	12	No revision	
Norwich	150	30.00	30,832	1,876	" "	10	"	"
Weston	250	29.25	42,437	2,501	" "	8	"	"
Brampton	1,300	29.40	179,132	15,690	" "	8	"	"
Seaforth	400	41.25	102,941	6,769	" "	12	No revision as yet	
Mitchell	200	38.50	47,490	3,066	" "	10	"	"
Ottawa	4,500				$40 per H.P. and up	15	Special schedule	Schedule equivalent to about 6c per K.W.H.
Port Arthur	5,000				$25 per H.P. connected	Special, both flat and meter	No revision as yet	

west *via* Guelph, Preston, Berlin, Stratford, St. Marys and on to London, with local transformer stations at each of these points, the whole high-voltage line thus described comprising about 300 miles. At each of these local transformer stations the voltage is reduced to 13,000 for the purpose of supplying by additional local feeder lines, the different municipalities in the vicinity thereof. The effect of this method of distribution is to make it possible from the high-voltage circuit above described, in combination with the low-voltage local distributing lines, to supply the needs of practically every municipality within the district at the four corners of which are Toronto, Niagara Falls, St. Thomas and Stratford. Arrangements are being made for the extension of the lines to Windsor, Sarnia and other municipalities.

The general routes of the transmission lines already built are indicated upon the accompanying map.

Apportionment of Costs

The municipalities have agreed to pay the Commission for the power which they purchase, delivered at the municipal sub-stations at 13,000 volts, on the following basis, viz:

The contract price of the Ontario Power Company at Niagara Falls, plus

1. Four per cent. upon that part of the construction cost which is properly applicable to each participating municipality, plus
2. An annual amount sufficient to create a sinking fund which in thirty years shall completely pay for that portion of the construction cost which is applicable to each municipality, plus
3. That proportion of the line loss and the general operating and maintenance charges which is properly applicable to each municipality.

Each municipality assumes the responsibility for acquiring or providing the necessary local distributing system, and the maximum cost to the consumer will be the above charges made by the Commission, plus the respective local distributing costs.

The following schedule sets forth some of the chief financial factors of the project viewed from the standpoint of the consumer.

Standard Schedule Prices for Light and Power

The Commission, in 1909, requested that the persons responsible for the operation of the various municipal plants taking power through it, should, from time to time, meet and confer respecting matters of common interest. Acting upon this suggestion, several meetings of municipal engineers have been held. One of the questions taken up was the preparation of a base schedule of charges for the sale of electric light and power. Subsequently, standard schedules were prepared, approved by the Commission, and have been adopted by several of the municipalities. This schedule may be said to be the "catalogue prices"

for light and power. From these prices, discounts dependent upon the purchase costs of power, and other conditions existing in individual municipalities, are given. The base schedules, as adopted in 1911, are as follows:

LIGHTING RATES

Class 1.—*Residence Lighting:*

Fixed charge per 100 square feet of area lighted, 4 cents per month.

Additional charge per Kilowatt hour as metered, 3½ cents.

To determine the area lighted, the maximum outside dimensions of the building are to be taken, the product multiplied by number of residence floors, and total amount reduced by 10 per cent. for walls, etc; basement and attic not to be included, unless in whole, or in part, used as living or sleeping rooms.

Class 2.—*Commercial Lighting:*

(a) Stores and Theatres—10 cents per K. W. H. for first hour's daily use of installed capacity, and 3½ cents for each K. W. H. above.

(b) Signs and Display Lighting—Same, or flat rate option.

(c) Churches—One-half above rates.

(d) Factories—Same, if they are not using power. If they are, the transformer capacity required for connnected lighting load may be added to the motor load, and charged at power rates.

(e) Hotels—Same as stores. Peak load may be controlled.

Class 3.—*Flat Rates:*

For sign, window, and display lighting, $6.00 per month per K. W. connected.

The charge of 4 cents per 100 square feet, is standard, while the charge per kilowatt-hour varies with the cost of power to the municipality. The charge of 10 cents for commercial lighting is standard, while the charge for all use above the first hour's daily use varies with the cost of power to the municipality. The minimum is 3½ cents and the maximum 5 cents.

POWER RATES

The following are the yearly base rates for power together with discounts allowed:

H.P. of motors or peak load	1 to 3	4 to 10	11 to 25	26 to 50	51 to 100	101 up.
Flat rates per H. P. per year, based on installed H. P. or maximum demand	$50	$48	$45	$43	$41	$40
Differential rates:						
Fixed charge per installed H.P. per year or maximum demand.....	$15	$14.40	$13.80	$13.20	$12.60	$12
Meter rate per K. W.H. of consumption	3.5c.	3.0c.	2.5c.	2.0c.	1.5c.	1.25c.

Class "A"	24	hours	unrestricted	use	..	100	per	cent.	of	the	base rate
Class "B"	24	"	restricted	"	..	90	"	"	"	"	"	"
Class "C"	10	"	unrestricted	"	..	90	"	"	"	"	"	"
Class "D"	10	"	restricted	"	..	66⅔	"	"	"	"	"	"

Restricted Hours:

Oct. 15th	Oct. 31st.	5.30	p.m.	to	6.30	p.m.
Nov. 1st	Nov. 30th.	5.00	"	"	6.30	"
Dec. 1st	Jan. 15th	4.30	"	"	6.30	"
Jan. 16th	Feb. 15th	5.00	"	"	6.30	"
Feb. 16th	Mar. 1st.	5.30	"	"	6.30	"

Local Discount.—A Discount from these rates will be given by the municipality of *——per cent.

Prompt Payment Discount.—A discount of 10 per cent. on the whole bill will be allowed for payment within 10 days from date of bill.

If Consumer uses power in any higher class than that under which he is rated, he shall from that time be considered as automatically transferred to the new class for balance of the term of contract.

If found necessary to consider *power factor* the Hydro-Electric Clause to govern, except as per No. 11 condition.†

Eastern Municipalities Power Union

On December 14, 1910, representatives of Eastern Ontario, from municipalities extending from Napanee to Morrisburg, met in Brockville, and unanimously passed a resolution requesting the Hydro-Electric Power Commission to submit estimates for the cost of distributing electrical energy, in certain specified quantities, to the various municipalities represented at the meeting.

This meeting was the beginning of the Union of Eastern Ontario Municipalities. Other municipalities have since joined.

On April 7, 1911, at Brockville, the chairman of the Hydro-Electric Power Commission, Hon. Adam Beck, addressed representatives of nineteen eastern Ontario municipalities, and explained the hydro-electric arrangements which the Ontario Government had planned for them. In the course of his address Mr. Beck drew attention to the fact, that private interests had secured control of many of the water-powers, which, in the Trent valley, constitute natural sources of supply of hydro-electric energy for portions of Eastern Ontario.

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* The local discount varies from 0 to 33⅓ per cent. according to the cost of power to the municipality. For example, the municipality of London has provided for a discount of 10 per cent.

† "Condition No. 11.—All electrical and mechanical equipment used by the Consumer shall be subject to the reasonable approval of the Commissioners, and the Consumer shall so take and use the electrical energy as not to endanger the apparatus of the Commissioners or cause any wide or abnormal fluctuations of their line voltage. All motors shall be selected with reference to securing the highest feasible power factor at all loads. Minimum power factor when operating Consumer's maximum load shall be 80 per cent. for motors up to 10 H. P., and 85 per cent. above 10 H.P."

Co-operation Necessary to Protect Public Interests

Some of the more important of these Trent Valley water-powers, along the Trent Valley canal, are the property of the Dominion Government, and have been leased by the Government to private parties. Mr. Beck pointed out, that the carrying forward of the hydro-electric policy of the Ontario Government in Eastern Ontario was hindered, because recent leases had been given by the Federal Government upon conditions which did not adequately provide for the supply, by lessees, of hydro-electric energy to municipalities.

Mr. Beck stated, that when the Hydro-Electric Commission applied to the private interests controlling these Trent Valley powers, and expressed its desire to arrange for a supply of power to municipalities, the Commission was informed that all the power controlled by the private corporation was at present required for other purposes.

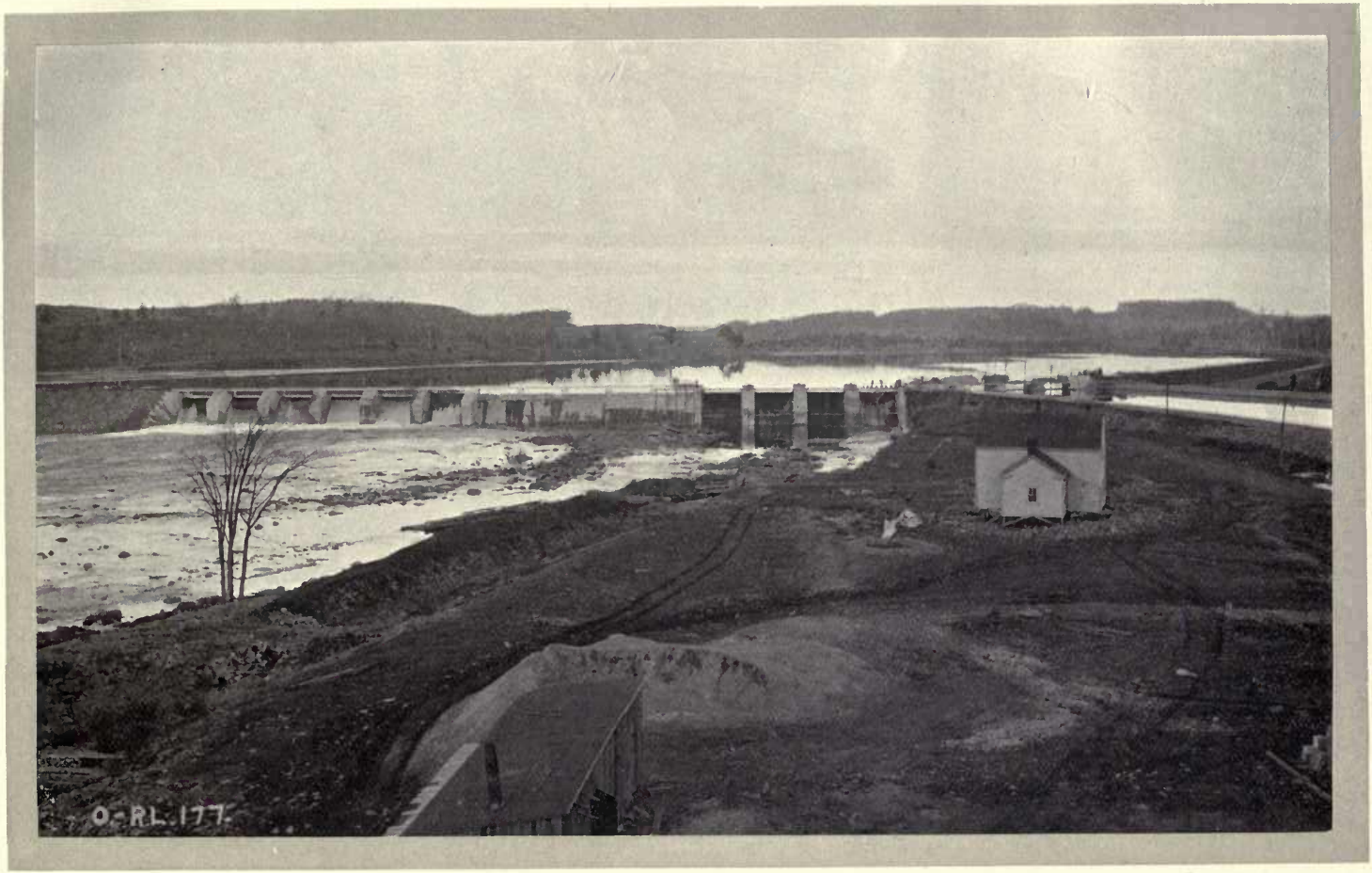
The experience which the municipalities of Eastern Ontario encountered, when they, through the Commission, approached the corporation which holds large interests in the Trent Valley water-powers, has, incidentally, accentuated to the municipalities of Canada at large, the value of such offices as are performed by a body like the Hydro-Electric Power Commission of Ontario.

Again, an instance of the kind above referred to shows how necessary it is to have sympathetic co-operation between the Federal and Provincial Governments, especially at times when there may be the equivalent of some overlapping of jurisdiction over certain assets of the country. If this is not done the best interests of the people may seriously suffer.

Proposed Contracts Waddington N.Y. and Madawaska

As has been intimated, the private control of these Trent Valley water-powers forced the Commission to seek its supplies of power from, somewhat, less advantageously located power sites. The Hydro-Electric Power Commission has contracted with the New York and Ontario Power Co., of Waddington, N.Y., for the delivery of 15,000 horse-power. The contract is framed along lines similar to the contract made with the Ontario Power Co., of Niagara Falls. The New York and Ontario Power Co., agrees to deliver 5,000 horse-power in ten months, after that, in blocks of 100 horse power until the contract limit is reached in 18 months. The prices for horse-power delivered at the sub-station of the Commission in Ontario are:

For not less than	2,000	horse-power	.....	$13.00
Then for all up to	4,000	"	"	12.50
Then for all up to	6,000	"	"	12.00
Then for all up to	8,000	"	"	11.50
Then for all up to	10,000	"	"	11.00
Then for	10,000	"	" (and over)...	10.50



Dam No. 1, Trent Canal, Hastings Co., Ontario

Four distributing stations are proposed, viz., one at Brockville, another at Morrisburg, a third at Kingston, and a fourth at Gananoque.

The total estimated cost of the transmission lines and transformer stations for distributing the power from Waddington to the municipalities mentioned below is $652,000.

The Commission also contemplates contracting for 20,000 horse-power from a company developing at High falls on the Madawaska river. This transmission line from High falls would tie in with the line from Waddington at a joint distributing station at Kingston.

Estimated Costs

The estimated costs of power per horse-power, in the quantities indicated, to various municipalities who have applied for same, are as follows:

ONTARIO

ESTIMATE OF COST OF POWER PER H.P. TO EASTERN MUNICIPALITIES *

Municipality	Power applied for		Power applied for plus 50%		Power applied for plus 100%	
	H.P.	Price.	H.P.	Price.	H.P.	Price.
Napanee	200	36.23	300	28.44	400	22.09
Kingston	1200	29.45	1800	23.76	2400	19.20
Lansdowne	100	55.38	150	34.13	200	26.81
Brockville	1000	20.49	1500	17.49	2000	15.37
Lyn	150	22.43	225	18.83	300	16.31
Prescott	500	18.17	750	15.86	1000	13.95
Cardinal	100	16.18	150	14.50	200	12.90
Morrisburg	2000	13.85	3000	12.93	4000	11.67
Athens	73	39.07	112	30.05	150	24.68
	5223		7987		10650	

Lindsay, Midland, and Penetanguishene

The Commission has under consideration proposals for the supply of electrical energy to the town of Lindsay from Fenelon falls, on the Trent river; and to the towns of Midland and Penetanguishene, from the development at the Big chute, on the Severn river.

Commission's Additional Functions

The Commission already undertakes many important duties besides those connected with the construction works above referred to. For example, estimates of cost are furnished municipalities who enquire about possible supplies of hydro-electrical energy. Measurements are made of stream flow, and special hydraulic surveys have been made of sites proposed for special power development. Much of this work is performed with a view to enable

* The above prices, as quoted to municipalities, include cost of power at falls, lost power, operation, administration and interest. These prices are preliminary estimates and subject to modification.

municipalities which cannot be supplied from Niagara power, to obtain a fair figure through the Commission from companies generating in their respective vicinities. In some instances, the Commission itself undertakes to construct the necessary works.

Again, as notably in the instances of the cities of Ottawa and Port Arthur, the Commission has been called upon to deal with difficulties existing between municipal and private interests, with the result that the difficulties have been removed and all parties financially benefitted.

Future of the Commission

It is the Commission's intention, in the early future, to take up the work of distributing power and light to the farmer and to small villages through the agency of the township councils. This work will enable the farmer to use cheap power for operating his agricultural and dairy appliances.

In addition to the functions referred to in the foregoing survey, and besides exercising a supervision over its extensive interests, the Commission anticipates taking up the work of making and enforcing orders and regulations relating to the construction, operation, protection, and inspection of the works, plant, machinery, appliances, and equipment for the transmission and distribution of electrical power by municipal corporations, and by railway, power or transmission companies. Legislation has already been provided to accomplish these objects.*

Power Development on the Niagara River

Since 1905, the general situation regarding the development of water-power on the Niagara river, and at Niagara falls in particular, has acquired a very different status from what it had before. For years the supply of Niagara's waters for power purposes was regarded as practically inexhaustible. To acute observers, however, it was evident that, even up to 1906, under the powers and privileges which had been granted to various companies in the United States and Canada, it might have become possible for them to drain the Niagara river, and, in addition, to draw upon the waters of lake Erie. As the true state of affairs at Niagara, and the consequent possibilities became better apprehended, public opinion began to take definite form in favour of the preservation of the scenic grandeur of the great cataract. Another factor was that, in many instances where water-powers had passed into private or corporate control, there was a disposition to sell the developed hydro-electric power at a small fraction under the cost of steam, thus depriving the people of the benefits of one of their greatest natural heritages.

Members of the American Civic Association, the American Scenic and Historical Society, the Colonial Dames of America, and other organizations were zealous in their efforts to secure the preservation of the scenic grandeur

* 1 George V, chap. 14 and 1 George V, chap. 15 (Ontario).

of the Falls.* The efforts of such organizations in the United States and in Canada were the immediate influences which resulted in definite action being taken to preserve the Falls and the scenic beauty of the Niagara river.

In the United States charters for power development had been granted by the state of New York, while, in Canada, charters had been granted by the Governments of the Dominion and of the province of Ontario. There were three prominent features which constituted the underlying principles upon which the jurisdiction of Federal authority was based.

FIRST.—The Niagara is a navigable river for the greater part of its length. It was recognized that, although the waters in some portions are not navigable by reason of falls and rapids, yet the control of such portions is essential to the maintenance of the navigability of other portions of the river and of lakes Erie and Ontario.

SECOND.—The Niagara river is a boundary stream. It is the duty of the government of a country to maintain the proper regimen of such a river, so as to insure its integrity and proper volume.

THIRD.—The scenic beauty of Niagara falls was regarded as a natural heritage belonging to the nation as a whole, and, as such, it was conceived that this great cataract should be conserved and not injured by excessive diversion of the waters of the rapids and falls.

Aesthetic Value of Niagara

In passing, it may be pointed out that the commercial value of what is called the "scenic beauty" of Niagara falls and rapids is apt to be overlooked on account of the purely academic significance which frequently attaches to aesthetic considerations. Every Canadian possesses a commercial asset, so to speak, in the Niagara river. This phase of Niagara interests is well brought out in a statement published, in 1911, by the American Civic Association, which says:

> "Abraham Lincoln, in notes for a lecture on Niagara Falls, said that the value of the great cataract was not so much in its grandeur as in its power to excite reflection and emotion in the people who saw it. He might, had he known how travel would be stimulated, have gone further and added some statement as to its value as a cash-producing asset to the people of the United States.
>
> "The army engineers, who have, under the direction of the Secretary of War and in connection with the findings of the International Waterways Commission, been for several years working at and about Niagara Falls, estimate that not less than 800,000 visitors annually

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* *Re* American Civic Association, see Senate Report No. 1611, (Calendar No. 1562), 59th Congress, 1st Session.

Re Am. Sc. and Hist. Soc., see Document No. 5, Committee on Rivers and Harbors, House of Representatives, 59th Congress, 1st Session.

Re Colonial Dames of America, see *Sessional Papers* (Canada), No. 19a, 1907, p. 260.

come from a distance to see the great cataract. It has been estimated further that the average amount expended per person is not less than $25, resulting in a gross travel income for the mere sight of Niagara Falls of $20,000,000 per year. Capitalized at 5 per cent. this would represent a value to the American people of $400,000,000, considerably more than the cost of the Panama Canal. That is, every man, woman and child in the United States has an ownership of about $4, in Niagara Falls, which pays a five per cent. annual revenue in money diverted completely and immediately into the channels of trade, ultimately reaching all of the owners.

"Obviously, the value of Niagara Falls to the people of the United States, aside from Lincoln's reason for their existence, and in simple dollars and cents, is far greater as a spectacle to attract travel than as a source of water power for a few stockholders and for the promotion of restricted industry."

The foregoing statement will emphasize to Canadians how great is the aesthetic value which they possess in the Niagara falls and rapids when viewed from a commercial standpoint.

The President Takes Action

Having decided upon the need for Federal action, the President recommended in his message to the 59th Congress, that action be taken for the preservation of Niagara falls.* Congress adopted a resolution of the Committee on Rivers and Harbours calling upon the United States members of the International Waterways Commission to report upon the general conditions obtaining at the Falls, and requesting, further, that there be co-operation with the Canadian members of the Commission to the end that proper and adequate steps be taken to prevent further depletion of the waters of the Niagara.† The matter was brought to the attention of the Canadian section of the Commission and their co-operation was heartily given.‡

It seemed fitting that the International Waterways Commission should undertake this work, because, while recognizing the desirability of the temporary diversion of certain waters for the development of power, yet, it had previously laid down as one of its fundamental principles, that "In all navigable waters the use for navigation purposes is of primary and paramount right." The changes brought about in the power situation at Niagara falls have occurred, therefore, largely through the immediate in-

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* See Message to Congress, March 27, 1906, 59th Congress, 1st Session, Senate Doc. No. 242.

† See House of Representatives, Report No. 4654, 59th Congress, 1st Session p. 2; also, *Sessional Papers*, (Canada,) No. 19a, 1907, p. 98; also, *Second Progress Report*, United States Section, International Waterways Commission, p. 4.

‡For recommendations respecting the advisability of having a treaty, see report of April 25th, 1906, made by the Canadian section, *Sessional Papers* (Canada), 1907, No. 19a, pp. 101-102.

strumentality of the joint sections of the International Waterways Commission.*

The authorities whose duty it was to make the recommendations regarding the diversion of the water of the river proceeded to work largely upon the basis that no serious hardship could result from withdrawing the charter powers of those who had failed to exercise the same; and that where companies had exercised their powers and had construction works either erected, or under erection, no serious hardship would befall if their use of water was restricted to, but at the same time made sufficient for, all the requirements of the installations which had been completed, or were then in progress of construction. In accordance with these views, a thorough investigation by Capt. Charles W. Kutz, of the United States Engineers, under the authority of the United States Secretary of War, was made into the power situation at Niagara Falls on both sides of the international boundary.†

Capt. Kutz' research involved the furnishing of exact information with respect to the capital which had been invested in all the power plants; the extent to which these plants were in actual use; the number of cubic feet of water actually in use; the amount of electrical power actually generated; the contracts made by these companies for the furnishing of power; the charters of the companies, and their statutory powers; the amount of power which under their charter or statutory powers, they might produce; the amount of actual construction completed; the amount of money invested in partially completed plants; the amount necessary to complete them; the amount of electrical current then being furnished; the amount which could be reasonably furnished with the plant under construction, and the amount that could be sold in the existing markets by these companies; and all the other circumstances tending to reflect on the effect which a limitation by a permit would have upon their business.

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* The International Waterways Commission originated under a provision of the Rivers and Harbours Act of the United States, June 13, 1902. The Canadian section held its first meetings in Ottawa, on March 6 and 7, 1905. The United States section held its first meeting in Washington, D.C., on May 10, 1905. The first meeting of the full Commission was held at Washington, D.C., May 25 and 26, 1905. See *First Progress Report of the Canadian Members of the International Waterways Commission*, 1905, for reference to papers and documents appertaining to the formation of the Commission.

†Reports upon the existing water power situation at Niagara Falls, so far as concerns the diversion of water on the American side, are published as U. S. War Dept. Document, No. 289. Washington, 1906.

Reports upon the existing water-power situation at Niagara Falls, so far as concerns the Canadian power companies and their associated transmission companies, are published as U. S. War Dept. Document No. 284.

The bulk of the capital in some of the plants on the Canadian side of the river was invested by citizens of the United States. Therefore, the research into power conditions also required that information be furnished regarding "the capital already invested in the Canadian companies, the degree of completion of the plant, the amount of the current likely to be sold on the Canadian side; the time when the plant shall be ready for operation; the amount now actually produced; the amount now actually transmitted to the United States; the amount invested not only in the production of the current, but in the plant and machinery for its transmission, including the poles and wires and all the details; and also the capital invested by the American companies who are to receive in the first instance the current thus produced; the form in which the capital is, and the contracts into which they have entered both with the Canadian companies and with the companies or persons to whom they expect to sell the current; the dates of these contracts, and all the circumstances tending to show the extent of the injury that a refusal to grant the permits requested would cause to the investment of capital, together with the question of when the contracts were made upon which the claims for the use of current are based, with a view to determining the good faith with which these contracts were entered into; and whether the threatened passage of law induced their making."

Kutz' Report

In due course Captain Kutz made his reports. The principal data relating to the three large Canadian companies as tabulated by him are as follows:*

DATA RESPECTING COMPANIES AT NIAGARA

Item	Ontario Power Co.	Electrical Development Co.	Canadian Niagara Power Co.
Expenditures to date in power plants exclu-clusive of rights and franchises	$5,142,000	$4,500,000	$4,672,000
Amount required to complete existing contracts and orders	715,000	1,760,000	678,000
Amount required to complete plants to projected size	6,500,000	1,576,000	1,250,000
Effective head, in feet	180	135	141
Capacity of generating machinery actually installed, electrical H.P.	42,000	.....	55,000
Nominal capacity of generating machinery installed and ordered, electrical H.P.	66,000	50,000	55,000
Nominal capacity of projected plants, electrical H.P	180,000	125,000	110,000

* See *Sessional Papers*, Canada, No. 19a, 1907, p. 272.

Data Respecting Companies at Niagara—*Continued*

Item	Ontario Power Co.	Electrical Development Co.	Canadian Niagara Power Co.
Amount invested and obligated for Canadian transmission lines	$1,000,000†	$2,620,000	$430,000*
Probable sale of power in Canada, H.P.	10,000	30,000	5,000
Amount of water required for machinery installed and ordered, including exciter sets, —efficiency of the unit being taken at 76 per cent—cubic feet per sec.	4,250	4,300	4,500
Amount of water required for plants as projected, cubic feet per sec.	11,700	10,800	9,500
Actual expenditures by their associated American transmission companies	$2,785,000	$246,000**	$600,000

Under the separate description of each of these companies given below will be found more recent data relating to some of the items specified in the table above given.

The Joint Commission Report

After report had been made to the United States section of the International Waterways Commission upon the matters involved in the research prosecuted by Capt. Kutz, the joint Commission on May 3rd, 1906, reported its conclusions as follows:†

> The Commission has made a thorough investigation of the conditions existing at Niagara Falls, and the two Sections have presented reports to their respective governments setting forth those conditions to which attention is invited. The following views and recommendations are based upon a careful study of the facts and conditions set forth in these reports.‡
>
> (1) In the opinion of the Commission, it would be a sacrilege to destroy the scenic effect of Niagara Falls.
>
> (2) While the Commission are not fully agreed as to the effect of diversions of water from Niagara Falls, all are of the opinion that more than 36,000 cubic feet per second on the Canadian side of the Niagara River or on the Niagara Peninsula, and 18,500 cubic feet per second on the United States side of the Niagara River, including diversions for

*The major portion of this amount has been expended in the construction of transmission lines intended for the delivery of power to United States distributing companies.

** This does not include any expenditures by the Nicholls Syndicate.

† Kutz' Report of August 15th is dealt with by the United States section of the Commission in its report of Sept 29th, 1906, and his report of October 5th in the Commission's report of Nov. 15th, 1906.

‡ See *Sessional Papers*, Canada, No. 19b, 1908, p. 13.

power purposes on the Erie canal, cannot be diverted without injury to Niagara falls as a whole.

(3) The Commission, therefore, recommend that such diversions, exclusive of water required for domestic uses or the service of locks in navigation canals, be limited on the Canadian side to 36,000 cubic feet per second, and on the United States side to 18,500 cubic feet per second (and in addition thereto a diversion for sanitary purposes not to exceed 10,000 cubic feet per second, be authorized for the Chicago Drainage Canal), and that a treaty or legislation be had limiting these diversions to the quantities mentioned.

(4) The effect of the diversion of water by the Chicago drainage canal upon the general navigation interests of the Great Lakes system will be considered in a separate report.

(5) The Canadian section, while assenting to the above conclusions, did so upon the understanding that in connection therewith, should be expressed their views that any treaty or arrangement as to the preservation of Niagara falls should be limited to the term of twenty-one years, and should also establish the principles applicable to all diversions or uses of waters adjacent to the international boundary, and of all streams which flow across the boundary.

Recommended Apportionments

The quantity of water first recommended for diversion on the Canadian side was fixed at an amount which, it was assumed, would allow the companies on that side to complete the works which they had under construction. The amounts were as follows:*

Company	Diversion Recommended
Canadian Niagara Power Company	9,500 cub. ft. per second
Ontario Power Company	12,000 " " " "
Electrical Development Company	11,200 " " " "
Niagara Falls Park and River Railway Co.	1,500 " " " "
Welland canal, or its tenants (in addition to lock service)	1,800 " " " "
Total allowable diversion recommended	36,000 " " " "

On the American side, the works in operation or in course of construction, were estimated to require as follows:†

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* See *Sessional Papers*, Canada, No. 19a, 1907, p. 140.

† This quantity under the Burton Act was subsequently reduced to 15,600 and under the International Boundary Waters Treaty increased to 20,000 cubic feet per second. See *Sessional Papers*, Canada, No. 19a, 1907, p. 140, also p. 264 *et seq.*

Company	Diversion Recommended.
Niagara Falls Hydraulic and Manufacturing Company.	9,500 cub. ft. per second
Niagara Falls Power Company	8,600 " " " "
Erie canal, or its tenants (in addition to lock service)	400 " " " "
Total allowable diversion recommended	18,500 " " " "

In deciding upon the 18,500 cubic feet per second, consideration was taken of the fact that the Chicago Drainage canal would take 10,000 cubic feet per second of water which otherwise would have found its way into the Niagara river so that the recommended diversion on the United States side was really 28,500 cubic feet per second.*

The United States section of the Commission recommended that permits† be granted for the importation of power into the United States as follows:

Company	Importation
The Ontario Power Company	60,000 H.P.
The Canadian Niagara Power Company	60,000 "
The Electrical Development Company	37,500 "
The International Railway Company (to be reserved but permit not to be granted immediately)	2,500 "
Total	160,000 "

* In making this recommendation, the members of the United States section of the International Waterways Commission, in their report of 19th March, 1906, to the Secretary of War, state that "One of the effects of such legislation would be to give to Canada the advantage of diverting 7,500 cubic feet per second more than is diverted in the United States. The advantage is more apparent than real, since the power generated on the Canadian side will to a large extent be transmitted to and used in the United States." See *Sessional Papers*, Canada, 19a, 1907, pp. 252-253.

Considering the plants on both sides of the river at Niagara Falls, it takes about .075 cubic feet of water per second to develop one electrical horse-power. On this basis therefore, the 160,000 H.P. to be imported into the States from Canada is equivalent to about 12,000 cubic feet of water per second. This quantity, with the 10,000 cubic feet per second, diverted by the Chicago Drainage Canal, and the 20,000 cubic feet per second, allotted under the International Boundary Waters Treaty, in effect, gives the States benefits from the use of about 42,000 cubic feet of water per second. Compared with this 42,000, Canadians would have for use in their own country, benefits from about 24,000 (viz. 36,000—12,000) cubic feet of water per second. This will explain the pertinence of a remark such as was made by the United States section of the Commission to the effect that in the amount of the waters diverted on the Canadian side, Canada's "advantage is more apparent than real."

† See *Infra*, page 65.

The Burton Act

In 1905, negotiations had been opened up between the United States Government and the British Ambassador at Washington with the object of arranging a treaty between Great Britain and the United States dealing with the waters along the international boundary, between the United States and Canada.* Subsequently these negotiations were interrupted pending the report of the International Waterways Commission upon the power conditions at Niagara falls.** When the United States section of the International Waterways Commission reported to its government regarding the preservation of Niagara falls, the President recommended to Congress that the suggestions of the Commission be enacted into law without waiting for the negotiation of a treaty, the law to lapse in three years, failing international agreement during that time.

Accordingly, on June 29, 1906, "A Bill for the Control and Regulation of the Waters of Niagara River, for the Preservation of Niagara Falls, and for Other Purposes," was passed and received the approval of the President. This act, known as the Burton Act, was regarded merely as a temporary measure.†

The Burton Act provides for the issuance by the United States Secretary of War, of four kinds of permits appertaining to the waters of the Niagara river and the power developed therefrom:‡

First.—Permits to divert water from the Niagara river on the American side to an aggregate amount not exceeding 15,600 cubic feet per second.

Second.—Revocable permits to divert additional water from the Niagara river on the American side to such amount, if any, as shall not injure the river as a navigable stream or as a boundary stream, and shall not injure the scenic grandeur of Niagara falls. But no such permits shall be issued until approximately the 15,600 cubic feet per second mentioned above shall have been diverted for a period of not less than six months.

Third.—Permits to transmit electrical power from Canada into the United States to the aggregate amount of 160,000 H.P.

Fourth.—Revocable permits for the transmission of additional electrical power from Canada into the United States, but in no case shall the

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* Regarding items recommended by the Canadian section of the International Waterways Commission for embodiment in the proposed treaty see *Sessional Papers*, Canada, 19a, 1907; pp. 101–102.

** See *Sessional Papers*, Canada, 19a, 1907; pp. 97–98; also pp. 262 *et seq.*

† Public Document No. 307. See United States *Statutes at Large*, 59th Congress, 1st Session, Vol. xxxiv, Part 1. Chap. 3621, pp. 626–628.

‡ See *Sessional Papers*, Canada, No. 19a, 1907, p. 265.

Courtesy Ontario Power Co.

MAP OF NIAGARA FALLS SHOWING LOCATION OF POWER DEVELOPMENTS

amount included in such permits, together with the 160,000 H.P. mentioned above and the amount generated and used in Canada, exceed 350,000 H.P.

Apportionment by the U.S. Secretary of War

As a result of all the investigations, public hearings, and reports upon the subjects involved, the Secretary of War in his *Opinion*, decided to grant permits*

(1) to divert water on the American side and (2) for export of power from Canada to the United States. The following is a list of the permits granted to divert water on the American side:

Company	Diversion Permitted
Niagara Falls Power Company	8,600 cub. ft. per second
Niagara Falls Hydraulic Power and Manufacturing Company	6,500 " " " "
Lockport Hydraulic Company (Erie Canal)	500 " " " "
Total	15,600 " " " "

The permits issued to import power from Canada to the United States were as follows:

Company	Amount
International Railway Company	1,500 H.P.
Ontario Power Company	60,000 "
Canadian Niagara Falls Power Company	52,500 "
Electrical Development Company	46,000 "
Total	160,000 "

The Burton Act would have expired by limitation on June 29th, 1909, but a joint resolution was approved on the 3rd of March, 1909, extending the operation of the Act for a further term of two years, viz: until June 29th, 1911.†

* *Annual Report of the Secretary of War*, 1907, Washington, 1908, p. 34. Applications for permits were made by the four Canadian companies for the exportation of power into the United States under the Burton Act to the extent of 282,000 H.P., as follows: International Railway Company, 8,000 H.P; Ontario Power Company 90,000 H.P.; Electrical Development Company, 62,500 H.P.; Canadian Niagara Power Company, 121,500 H.P. See *Opinion by the Secretary of War*, Jan. 18th, 1907.

† House Joint Resolutions No. 262. See United States *Statutes at Large*, 60th Congress, 2nd Session, Vol. xxxv, Part 1, p. 1169.

Electricity and Fluid Exportation Act

After the Burton Act was passed the Government of Canada, on April 27, 1907, passed an Act intituled "An Act to Regulate the Exportation of Electric Power and certain Liquids and Gases."*

This Act prohibits the exportation of any power or fluid except under government license, and subject to such regulations as, from time to time, may be imposed by the Governor in Council.

Clause 10 of the Act states, that

> 1. The Governor in Council may, by proclamation published in the The Canada Gazette, impose export duties, not exceeding ten dollars per annum per horse-power, upon power exported from Canada, or not exceeding ten cents per thousand cubic feet on fluid exported from Canada, and such duties shall be chargeable accordingly after the publication of such proclamation.
>
> 2. The Governor in Council may, by proclamation published in like manner, from time to time remove or re-impose such duties or vary the amount thereof.
>
> 3. The Governor in Council may, by proclamation published in like manner, exempt from the payment of such duties such persons as comply with the direction of the Governor in Council with regard to the quantity of power or fluid to be supplied by such persons for distribution to customers for use in Canada.

On November 4, 1907, an Order in Council was passed establishing the Regulations. The licenses are for the term of one year. Under clause 3 of the Regulations

> The contractor, shall, on or before the 1st day of April of each year, make application for the license referred to in the previous paragraph and shall pay therefor the following fee, namely:
>
> (*a*) In the case of an electrical plant generating not more than 10,000 horse-power, twenty-five dollars;
>
> (*b*) In the case of an electrical plant generating over 10,000 horse-power, fifty dollars;
>
> (*c*) In the case of a natural gas plant, fifty dollars.

The amounts of electrical energy for which licenses have been granted to Canadian Niagara companies, also the quantities of electrical energy generated for export and for consumption in Canada during the fiscal year ended March 31, 1910, are:†

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* Dominion Statutes 6-7 Ed. VII, chap. 16; the *Act*, the *Regulations* of Nov. 4, 1907, and the *Form of License* will be found in the Appendices.

With regard to some matters related to the exportation of electricity see, *The Exportation of Electricity*, by Arthur V. White, in *The University Magazine*, Oct. 1910, pp. 460-467.

† Consult *Reports, Returns and Statistics of the Inland Revenues of the Dominion of Canada*, Ottawa, 1910, Appendix K, p. 68.

POWER GENERATED AT NIAGARA

Name of Contractor	Licences to Export	Units Generated for Export		Units Generated for Consumption in Canada	
	Kilowatt Years	Kilowatt Hours	H.P. Years	Kilowatt Hours	H.P. Years
Canadian Niagara Power Company ..	39,165	276,866,417	42,351·60	5,590,383	855·20
Electrical Development Company of Ontario, Ltd.	34,316	22,496,703	3,441·25	101,155,973	15,473·65
Ontario Power Company of Niagara Falls	45,000	174,116,995	26,631·10	74,853,105	11,450·12

Power Reserved For Canada

In the agreements between the Niagara Falls Park Commissioners and the Canadian Niagara Power Co., the Ontario Power Co. and the Electrical Development Co., it is agreed that the quantity of power to be supplied in Canada, whenever so required, is to be not less than one-half of the quantity generated.*

International Boundary Waters Treaty

Section 4, of the Burton Act states, "That the President of the United States is respectfully requested to open negotiations with the Government of Great Britain for the purpose of effectually providing, by suitable treaty with said government, for such regulation and control of the waters of Niagara river and its tributaries, as will preserve the scenic grandeur of Niagara Falls and of the rapids in said river."

In accordance with this section, negotiations between the Governments of Great Britain and the United States, which had been interrupted, were resumed, and the International Boundary Waters Treaty, was signed at Washington 11th January, 1909. A rider was subsequently attached by the United States Senate, March 3, 1909.† The treaty remains in force for five years, dating from the day of exchange of ratifications, and thereafter until terminated by twelve months' written notice given by either of the contracting parties. Ratifications were exchanged at Washington, May 5, 1910.

* See *Report* Q.V.N.F.P. Commissioners, 1892, p. 6; 1899, p. 34; also, 1902, p. 38.

† For re-opening of negotiations, see *Sessional Papers*, Canada, No. 19a, 1907, p. 262 *et seq.*

The matters covered by the treaty are placed under a Commission known as the International Joint Commission, composed of six commissioners, three on the part of the United States, and three on the part of the United Kingdom appointed by His Majesty on the recommendation of the Governor in Council of the Dominion of Canada. This Commission is essentially a continuance of the Joint International Waterways Commission.

With regard to the disposal of the waters of the Niagara river, Article V of the treaty states that

> "The high contracting parties agree that it is expedient to limit the diversion of waters from the Niagara river, so that the level of lake Erie and the flow of the stream shall not be appreciably affected. It is the desire of both parties to accomplish this object with the least possible injury to investments which have already been made in the construction of power plants on the United States side of the river under grants of authority from the state of New York, and on the Canadian side of the river under licenses authorized by the Dominion of Canada and the province of Ontario.
>
> So long as this treaty shall remain in force no diversion of the Niagara river above the falls from the natural course and stream thereof shall be permitted except for the purposes and to the extent hereinafter provided.
>
> The United States may authorize and permit the diversion within the state of New York of the water of the said river above the falls of Niagara, for power purposes, not exceeding in the aggregate a daily diversion at the rate of twenty thousand cubic feet of water per second.
>
> The United Kingdom, by the Dominion of Canada, or the province of Ontario, may authorize and permit the diversion within the province of Ontario of the waters of said river above the falls of Niagara, for power purposes, not exceeding in the aggregate a daily diversion at the rate of thirty-six thousand cubic feet of water per second.
>
> The prohibitions of this article shall not apply to the diversion of water for sanitary or domestic purposes, or for the service of canals for the purposes of navigation."

The water which may be diverted at Niagara falls, so far as the United States is concerned, aggregates 20,000 cubic feet per second, whereas the Burton Act limited it to 15,600 cubic feet. The quantity for diversion upon the Canadian side as specified in the treaty, is 36,000 cubic feet per second.

Power Companies at Niagara Falls

The policy the International Waterways Commission adopted in apportioning the waters of the Niagara river and of lake Erie was to

grant water-diversion permits to the companies that had power development plants already constructed or under construction.

On the Canadian side, these companies are:
Canadian Niagara Power Company of Niagara Falls;
Ontario Power Company of Niagara Falls;
Electrical Development Company of Ontario, Ltd. (Toronto Power Company);
Niagara Falls Park and River Railway Company (The International Railway Company);
Welland canal or its tenants (in addition to lock service).

On the United States side, these companies are:
Niagara Falls Hydraulic Power and Manufacturing Company;
Niagara Falls Power Company;
Erie canal or its tenants (in addition to lock service).

In addition to the above-named companies, there are chartered companies on both sides of the river, some of whose statutory powers have expired by limitation. The franchises of some of them, however, are still in force. The following chartered companies have power rights in the Niagara, Welland and lake Erie waters. The character of their franchises, and the legislative acts under which their powers have been granted are indicated below. From time to time the names of the various companies have undergone change; therefore the following list, especially when used in connection with the short descriptive reference accompanying each, will prove of assistance in differentiating between them. The first column gives the present names of the development and transmission companies, while the second gives their former names and indicates the allied development and transmission companies.

Buffalo and Niagara Power and Drainage Co.	In state of New York.
Buffalo Water Works, Tunnel and Inlet Pier.	In state of New York.
Canadian Niagara Power Co.	
Cataract Power and Conduit Co.	In state of New York.
Dominion Power and Transmission Co., Ltd.	See Hamilton Cataract Power, Light and Traction Co., Ltd.
Electrical Development Company of Ontario, Ltd.	See Toronto Power Co.
Erie Ontario Power Co.	
Falls Power Co., Ltd.	See Ontario Power Co., of Niagara Falls.

Hamilton Cataract Power, Light and Traction Co., Ltd. .....See Cataract Power Company of Hamilton; Hamilton Electric Light and Cataract Power Co., Ltd; Dominion Power and Transmission Co., Ltd.

International Railway Co.....See the Niagara Falls Park and River Railway Co.; Buffalo Railway Co.

Jordan-Erie Power Co.....See Hamilton and Lake Erie Power Co.; Jordan Light, Heat and Power Co.; Erie and Ontario Development Co., Ltd.

Lewiston Water Supply Co. .....In state of New York.

Lockport Water Supply Co. .....In state of New York.

Lower Niagara River Power and Water Supply Co. .....In state of New York.

Mather Bridge and Power Co. .....

Niagara County Irrigation and Water Supply Co. .....In state of New York.

Niagara Falls Electrical Transmission Co.....In state of New York. See Electrical Development Co. of Ontario, Ltd.

Niagara Falls Hydraulic Power and Manufacturing Co. .....In state of New York.

Niagara Falls Power Co. .....In state of New York. See Niagara River Hydraulic, Tunnel Power and Sewer Co., of Niagara falls.

Niagara Gorge Power Co. .....In state of New York.

Niagara, Lockport and Ontario Power Co.....In state of New York. See Ontario Power Co., of Niagara falls.

Niagara Power and Development Co. In state of New York. See Model Town Co.

Niagara-Welland Power Co. .....See The Welland Power and Supply Canal Co., Ltd; The Niagara-Welland Power Co., Ltd.

North American Canal Co. .....

Ontario Distributing Co., Ltd. . . . .See Ontario Power Co., of Niagara falls.

Ontario Power Company of Niagara Falls.....See Canadian Power Co.

Ontario Transmission Co., Limited . . See Ontario Power Co., of Niagara Falls.

Toronto Power Co., Limited. . . . . See Toronto and Mimico Electric Railway and Light Co., Ltd; Toronto and Mimico Railway Co., Ltd.

Toronto and Niagara Power Co. . . . . See Toronto Power Co., Ltd.

Woodward Power Development.

Henry E. Woodward estate, ... In state of New York.

Canadian Niagara Power Company

This Company is an ally of the Niagara Falls Power Company of Niagara Falls, N.Y. As early as 1889 negotiations with the Queen Victoria Niagara Falls Park Commissioners for the privileges the Company now possesses were begun by a group of American capitalists. These overtures, however, were not successful. English capitalists then became interested and, on payment of $10,000, succeeded in securing an option for a year to develop power within the area controlled by the Park Commissioners. This option was renewed for a second year on payment of an additional $10,000, but was allowed to expire by limitation on Mar. 1, 1892.* The next step was taken by a group of English and United States capitalists—subsequently incorporated as the Canadian Niagara Power Company. By an agreement, confirmed by the Ontario Legislature in April, 1892, they secured the exclusive right to utilize the waters of the Niagara river within the limits of the Queen Victoria Niagara Falls Park.**

At a later date, the Legislature passed an act conferring on the Park Commissioners authority to negotiate with the Company for the surrender of the exclusive privileges granted it.*** On July 15, 1899, in return for certain concessions, the Company abandoned its exclusive rights.† Still further restrictions were placed upon the Company's operations on June 19, 1901, when it obtained an extension of the time limit for the construction of its works.‡

TERMS OF LICENSE.—The Licenses granted are for 50 years, beginning from the 1st day of May, 1899. The Company at its option may have three renewal periods of 20 years each, making the total period under its

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* For early negotiations, see *Annual Reports* of the Queen Victoria Niagara Falls Park Commissioners, 1889-1892.

** Ontario Statutes, 55 Vict., chap. 8.

*** Ontario Statutes, 62 Vict., chap. 11, sec. 35–36.

† Report of Q. V. N. F. P. Commissioners for 1899, pp. 11–18.

‡ Report of Q. V. N. F. P. Commissioners for 1901, pp. 14–16; Agreement for Shaft, pp. 17-18; for additional legislation consult, Ontario Statutes, 2 Ed. VII, chap. 11; 3 Ed. VII, chap. 7, sec. 59; 4 Ed. VII, chap. 10, sec. 69; 6 Ed. VII, chap. 19, sec. 44 and 45; 7 Ed. VII, chap. 13. For cross section of intake, consult Plan, entitled, "Stone Bridge over Canal Inlet," dated Niagara Falls, Feb. 27, 1902.

option 110 years. The Lieutenant-Governor in Council may require the Company to continue its operations for a further term of 20 years, thus making, in all, 130 years. Provision is also made for the re-adjustment of rentals at each renewal period.

The Company agrees to pay for its privileges $15,000 per annum (payable half yearly) for the first 10,000 electrical H.P., and for each electrical horse-power "generated and used and sold or disposed of," *

From 10,000 to 20,000	at.	$1.00 per annum.
From 20,000 to 30,000	at.	.75 "
Over 30,000	at.	.50 "

Thus, by way of example, 40,000 H.P., disposed of would bring in an annual rental of $37,500.

Power Developed since 1906.—The average amount of power developed throughout each six-months' period beginning with April 30th, 1906, is as follows:

Apr. 30, 1906	12,206 H.P.
Oct. 31, 1906	12,551 "
Apr. 30, 1907	20,523 "
Oct. 31, 1907	29,697 "
Apr. 30, 1908	29,867 "
Oct. 31, 1908	34,695 "
Apr. 30, 1909	35,501 "
Oct. 31, 1909	40,440 "
Apr. 30, 1910	46,613 "
Oct. 31, 1910	46,394 "

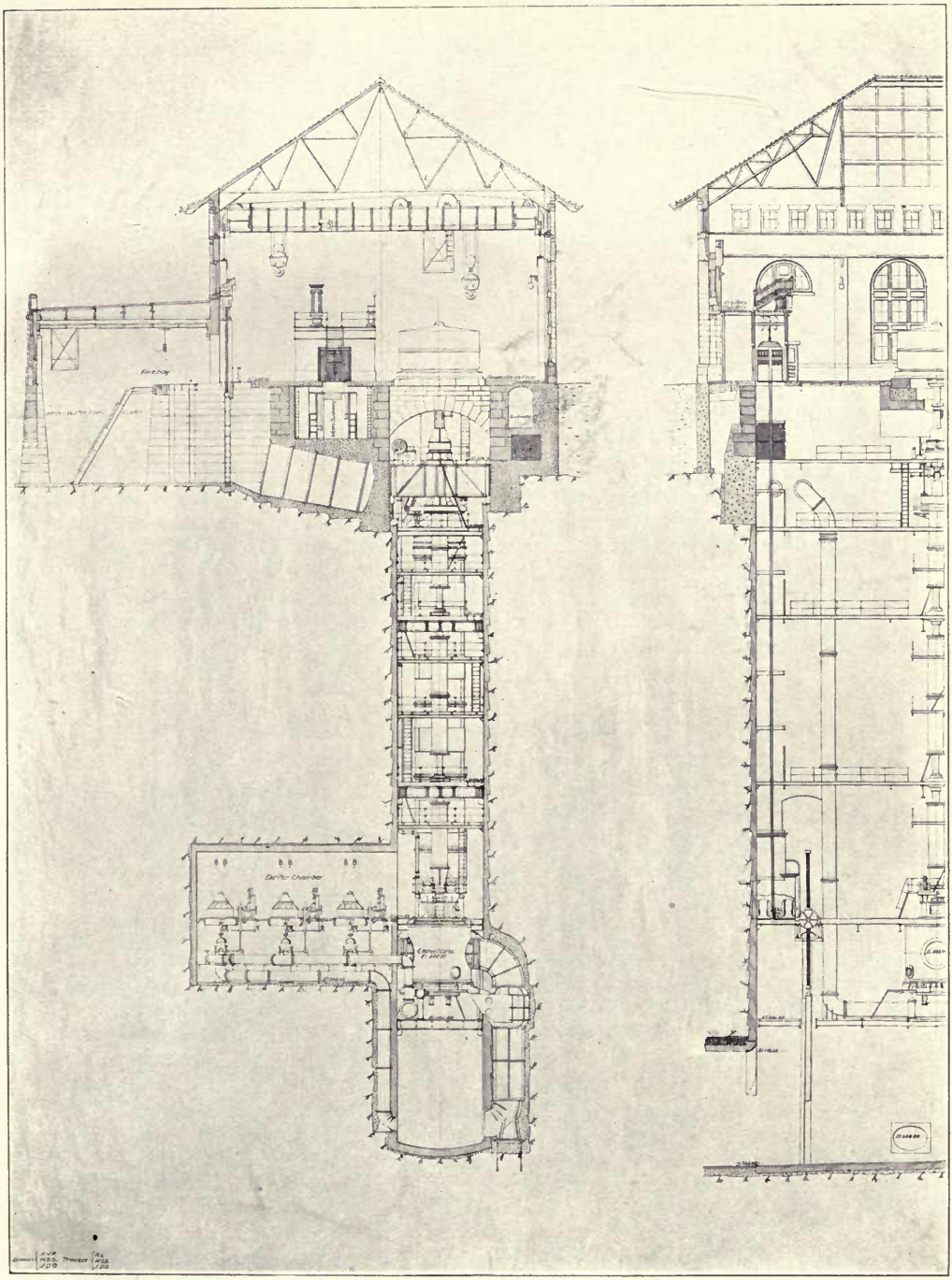
Capacity of Plant—The plans approved by the Commissioners show provision for 11 units, each having a nominal capacity of 11,000 H.P.† or a total of 121,000 H.P. If one of these units be considered as a spare one, then 110,000 H.P. may be regarded as the nominal capacity of the plant.‡

The amount of water that may be withdrawn from the river is not specified in the agreement, but, physically, the quantity would depend upon the practical velocity of flow that might be maintained through the

*Respecting dispute and litigation as to payments for excess power generated by certain Niagara companies, see, *Annual Reports* Q.V.N.F.P. Commissioners, 1908, 1910; also Agreements, Canadian Niagara Power Co., April 7, 1892, clause 2; Ontario Power Co., April 11, 1900, clause 26; Electrical Development Co., Jan. 29, 1903, clause 14.

† The last generator installed has a nominal rating of 12,500 H.P.

‡ In the agreement of 7th April, 1892, clause 1, provides that "a tract of land not more than 1,200 feet in length by not more than 100 feet in width" shall be reserved for the erection of the buildings and power houses from time to time to be erected as shall be hereafter settled within the aforesaid limits by the Commissioners. See also *Sessional Papers*, Canada, No. 19a, 1907, p. 270.



Courtesy Canadian Niagara Power Co.

CROSS–SECTIONAL VIEW OF THE PLANT OF THE CANADIAN NIAGARA POWER CO. AT NIAGARA FALLS

five spans of fifty feet clear each, having the special shape of span opening shown on the plan of the Canadian Niagara Power Company entitled, "Stone Bridge over Canal Inlet." The computed quantity of water required for the complete plant, which is also the quantity allotted the Company on recommendation of the International Waterways Commission, is 9,500 cubic feet per second.

Under the Burton Act, the company may import into the United States 52,500 H.P., exclusive of the amount that may be imported under revocable permits.

Ontario Power Company This Company came into existence in 1887 under the name of the Canadian Power Company* and did not assume its present name till July 10, 1899.** The privileges granted to it include

> "Full power to construct, equip, maintain and operate a canal and hydraulic tunnel from some point in the Welland river, at or near its conjunction with the Niagara river to a point or points on the west bank of the Niagara river, about or south of the whirlpool and from a point or points in the Niagara river at or immediately south of the head of the rapids near the Welland river to a point or points on the west bank of the Niagara river about or south of Clark Hill," together with appurtenant works necessary for carrying out the Company's purposes.

None of the works authorized may be constructed, and none of the powers given may be exercised within the Queen Victoria Niagara Falls Park, except with the consent of the Lieutenant-Governor in Council and the Park Commissioners.†

Accordingly, on April 11, 1900, the Company entered into an agreement,‡ usually termed the First Agreement, with the Queen Victoria

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* The Act of incorporation is 50–51 Vict., chap. 120 (Canada). Amending acts, most of which were for the purpose of extending the time for the construction of the works, are as follows: 54–55 Vict., chap. 126; 56 Vict.,chap. 89; 62-63 Vict., chap. 105; 63-64 Vict., chap. 113 and 2 Ed. VII, chap. 86.

** 62–63 Vict., chap. 105.

† Ibid.

‡ The Agreements, also Orders in Council and Resolutions for convenience in reference may be summarized as follows:

Agreement of 11th April, 1900; approved by the Lieutenant-Governor in Council 13th April, 1900. See *Ann. Rept.* Q. V. N. F. P. Com., 1899, pp. 25–36.

Supplementary Agreement 15th August, 1901; Ancillary Agreement, 15th August, 1901; adopted by Resolution of the Board of Directors of the Ontario Power Co., dated Buffalo, N.Y., 14th Oct., 1901. See *Ann. Rept.*, Q. V. N. F. P. Com., 1901, pp. 19–22; also pp. 22–24.

Complementary Agreement, 28th June, 1902; adopted by Resolution of the Board of Directors of the Ontario Power Co., 27th June, 1902; approved by Order in Council

Niagara Falls Park Commissioners, by which water might be conducted from the Welland river and used for power purposes under, so to speak, a double head. That is, the water was first to be conducted in an open channel, or head race, to a power house in the Park after which it would be discharged directly into the Niagara river at a point above the falls. By this scheme a head of about 40 feet was to be utilized. The spent waters in the tail race of this "First Development," as it was called, might next be conducted by a subterranean channel, to a proposed power house situated somewhere in the gorge below the falls, thereby utilizing the hydraulic head incident to the Horseshoe falls. In the agreement, this scheme is referred to as the "Second Development."

The plan approved for the Welland river intake is shown on the "Plan and Profile of Proposed Head Canal and Tunnel,"* dated Niagara Falls, October, 1901, which shows a canal, a typical cross section of which has a base 129 feet long with the sides sloping 1½ to 1. The canal is represented as carrying water about 18.6 ft. in depth. The water is to be conveyed to the Niagara river by three circular pipes or tunnels each of 16 ft. internal diameter.

For the privileges granted under the agreement, the Company are to pay an annual rental of $15,000 and, in addition, certain specified rentals based upon the actual amounts of power developed.

The Company, in addition to the rights obtained for conducting water from the Welland river, applied for rights to divert water from the Niagara river. Pursuant to this application, on June 28, 1902, an agreement known as the Complementary Agreement was made with the Commissioners. By this agreement the rights of location and construction relating to what is termed the First Development of the Agreement of 11th April, 1900, are surrendered, and the proposed open hydraulic canal running through the park abandoned. Instead, provision was made to conduct water from

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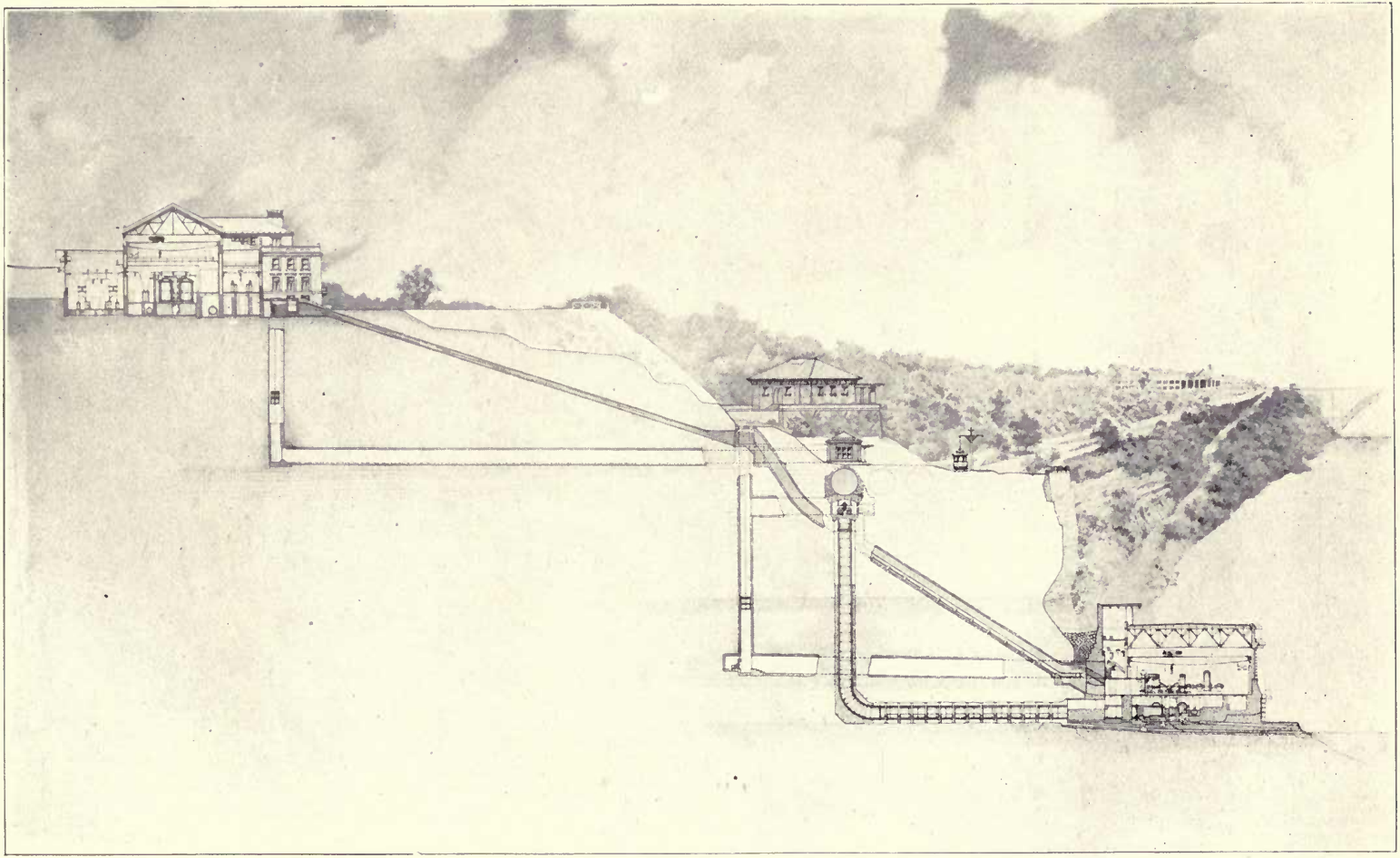
(containing provision relating to plans, &c) 7th August, 1902. See *Ann. Rept.* Q. V. N. F. P. Com., 1902, pp. 22–29.

Sub-agreement to the Supplementary and Ancillary Agreements, 28th June, 1902; Pipe Line and Power House Agreement, 28th February, 1903; adopted by Resolution of the Board of Directors of the Ontario Power Co., 3rd March, 1903; approved by Order in Council, 6th March, 1903. See *Ann. Rept.* Q. V. N. F. P. Com., 1903, pp. 22–27.

Agreement for conduit No. 2, 22nd September, 1909. See *Ann. Rept.* Q. V. N. F. P. Com., 1909, pp. 20–22.

Plans referred to in the various agreements are: plan A, dated Niagara Falls, April 5th, 1900, and accompanying agreement 11th April 1900; plan B, dated Niagara Falls, March — 1901, and accompanying agreement 15th August, 1901; plan C, dated Niagara Falls, June 24, 1902, and accompanying agreement 28th June, 1902; plan D, dated Niagara Falls, February 28th, 1903, and accompanying agreement 28th February, 1903.

* Filed in the Dept. of Railways and Canals, Ottawa, in conformity with sections 124 and 125 of the Railway Act, Nov. 29, 1901.



Courtesy Ontario Power Co.

CROSS–SECTIONAL VIEW OF THE PLANT OF THE ONTARIO POWER CO AT NIAGARA FALLS

the Welland and Niagara rivers, by means of parallel lines of underground pipes or conduits.

The Order in Council of Aug. 7, 1902, by which the Lieutenant-Governor approved the supplementary and ancillary agreements, contains the important proviso, that the approval is given, provided that the works, plans, profiles, specifications and elevations, are to be submitted for the approval of the Commissioners, and shall, before such approval is given, be approved by the Lieutenant-Governor in Council.

Consequent upon this provision there was submitted a map, drawn to a scale of 100 feet to the inch, entitled "Map showing proposed works of the Ontario Power Company at Dufferin Islands—Niagara Falls Intake," and dated Dec. 10, 1902. This plan shows the line of the three pipes, each of which is indicated as being 18 ft., internal diameter.

PLANT.—The power house of the Ontario Power Company is situated in the gorge below the falls and the intake near the Dufferin islands above the falls. The water is conveyed a distance of over 6,000 ft. by means of two underground conduits, each of 18 ft. internal diameter. The first conduit is built of steel, the second of reinforced concrete. From the main conduits, penstocks each of 9 ft. internal diameter and about 300 ft. long, lead to the turbines.

The amount of power which the Company is permitted to generate is not specified in the agreements, but in the reports of the Park Commission the amount is mentioned for the Niagara river intake as being that sufficient to generate 180,000 H.P. Plans of the works show provision for 22 units. Regarding 2 units as spares, the original nominal capacity of the plant is 200,000 electrical H.P. Originally each unit had a nominal capacity of 10,000 H.P.; but those last installed have a nominal capacity of 12,000 H.P. This increased capacity results in part from the advance made in the mechanic and industrial arts.

The plant operates under an average effective head stated to be about 176 feet. This, however, varies with the water level in lake Erie.

The amount of water that may be taken at the Niagara river intake is not stated in the agreements of the Company with the Park Commissioners but, physically, it would depend upon the velocity of flow that could practically be maintained in the three eighteen-feet conduits. The velocity of the water in the main conduits has been computed to be about 15 feet per second; and, in the penstocks, about 10 feet per second. The quantity required for the complete plant has been computed to be about 12,000 cubic feet per second, and this quantity has been allotted under recommendation of the International Waterways Commission.

TERMS OF LICENSE.—The license granted is for the term of fifty years commencing April 1, 1900. The Company has the option of three renewal periods of 20 years each, bringing the total period under option to 110 years. The Lieutenant-Governor in Council may, after giving specified notice, require the Company to continue its operations for a further term of 20 years, thus making, in all, 130 years. Provision is made for the re-adjustment of rentals at each renewal period.

Under the Complementary Agreement of June 28, 1902, provision is made, also, for the payment of one specified rental for the enjoyment of all the rights and privileges by all the agreements granted and conferred upon the Company. The Company is to pay a clear yearly rental of $30,000; payable half-yearly. In addition, for each electrical horse-power "generated and used and sold or disposed of,"

Over 20,000 and up to 30,000	$1.00 per annum
Over 30,000 and up to 40,000	.75 " "
Over 40,000	.50 " "

Thus, for example, for generating 40,000 H.P. the annual rental would be $47,500.

The average amount of power developed throughout each six months' period beginning April 1, 1908, is as follows:

April 1, 1908	13,535 H.P.
Sept. 30, 1908	20,177 "
April 1, 1909	32,192 "
Oct. 1, 1909	28,826 "
April 1, 1910	47,421 "
Oct. 1, 1910	45,023 "
April 1, 1911	54,765 "

The quantity developed by the Company which may be imported into the United States under the Burton Act (exclusive of the amount which may be imported under revocable permits) is 60,000 H.P.

The Ontario Power Company has contracted to supply the Hydro-Electric Power Commission with electrical energy as required, up to an amount aggregating 100,000 H.P., upon the following terms, viz:

$9.40 per horse-power per annum for power at 12,000 volts until 25,000 H. P. or more are taken, then $9 for all additional requirements; $10.40 for power at 60,000 volts until 25,000 H.P. or more are taken, then $10 for all additional requirements.

If power is taken at a higher voltage, the price is to be fixed by arbitration.

TRANSMISSION COMPANIES ALLIED WITH THE ONTARIO POWER CO.—The following power distributing companies in Canada are affiliated with the Ontario Power Co.:—

THE ONTARIO TRANSMISSION CO. is the chief distributing company in Canada for the Ontario Power Co. It was incorporated July 14, 1905, under a Dominion charter which granted wide powers, as may be seen from the following two clauses quoted from its charter:

(a) "To acquire by lease, purchase or otherwise lands and interests therein, water privileges, water-powers and other powers, and to utilize and develop the same, for the generation or production of electric, steam, pneumatic, hydraulic or other power or force."

(b) "To construct or acquire by lease, purchase or otherwise, and to operate and maintain undertakings, plant, machinery, works and appliances for the generation or production of steam, electric, pneumatic, hydraulic or other power or force; also lines of wire, poles, tunnels, conduits, works and appliances for the storing, delivery and transmission under or above ground of steam, electric, pneumatic, hydraulic or other power or force, for any purposes for which the same may be used. And to contract with any company or person upon such terms as are agreed upon, to connect the company's lines of wire, poles, tunnels, conduits, works and appliances with those of any such company or person; and generally to carry on the business of generating, producing and transmitting steam, electric, pneumatic, hydraulic or other power or force."

On Sept. 14, 1905, this company was granted an Ontario license.*

THE ONTARIO DISTRIBUTING CO. was incorporated by Ontario Letters Patent on Jan. 24, 1906, with powers for

"supplying steam heat, electricity or natural gas for heat, light or power, to construct, maintain, complete and operate works for the production, sale and distribution of electricity for the purposes of light, heat and power."

This company distributes power from the Ontario Power Company in the townships of Stamford and Niagara, Lincoln and Welland counties, Ontario.

THE FALLS POWER CO. was incorporated by Ontario Letters Patent, March 21, 1906; Supplementary Letters Patent, July 31, 1907, and Feb. 11, 1910. Amongst the powers granted is the right

"to acquire, produce, develop, convert and transform gas, electricity and hydraulic and pneumatic power and force for any purposes for which the same may be used."

This company distributes the power of the Ontario Power Co., in the townships of Bertie, Willoughby, Pelham, Thorold, Humberstone,

* Under Ontario Act, 63 Vict., chap. 24.

Crowland, Wainfleet and Grantham, Lincoln and Welland counties, Ontario.

THE NIAGARA, LOCKPORT AND ONTARIO POWER CO., chartered by the state of New York, has an extensive network of transmission lines throughout Western New York and distributes electrical energy for the Ontario Power Co., as far east, at present, as Syracuse.

Electrical Development Co. On Jan. 29, 1903, the Commissioners of the Queen Victoria Niagara Falls Park, entered into an agreement* with "a Syndicate" composed of William Mackenzie, Henry M. Pellatt and Frederick Nicholls, granting them privileges expressed, in part, as follows:

> "For the purpose of generating electricity and pneumatic power or any other power to be transmitted, and capable of being transmitted, to places beyond the park, the Commissioners hereby grant to the Syndicate subject to the consent and approval of the proper authority, and save as hereinafter limited, a license irrevocable to take from the waters of Niagara river within the park a sufficient quantity of water to develop 125,000 electrical, or pneumatic, or other horse-power for commercial use."

For these purposes the Commissioners further granted to the Syndicate

> "The right to construct and build and to do and perform and operate the works, as hereinafter described and located in pink lines upon the map or plan marked 'N' hereto annexed and entitled 'Plan Attached to Agreement Dated January 29th, 1903, made by the Commissioners of the Queen Victoria Niagara Falls Park with William Mackenzie, Henry Mill Pellatt and Frederick Nicholls for power privileges within the Park' and which plan is identified by the seals and signatures of the parties hereto."

On Feb. 18th, 1903, by Royal Letters Patent, under *The Ontario Companies Act*, the Syndicate was consolidated into The Electrical Development Company of Ontario, Ltd.†

The Electrical Development Co. is empowered

> "To acquire by lease, purchase or otherwise and to maintain, utilize and develop water-powers and other powers for the production of electricity and of electric, pneumatic, hydraulic or other power or force for any purpose for which electricity or power can be used."
>
> "To construct or acquire by lease purchase or otherwise and to maintain and operate works and appliances for the production of electricity and of electric, pneumatic, hydraulic or other power or force and lines of wire, poles, tunnels, conduits, conductors, motors, devices, works and appliances for the sale distribution and transmission under

* Confirmed by Order in Council, Jan. 30, 1903.

† Supplementary Letters Patent regarding stock issues and other rights were granted on Feb. 28th, 1908; and on June 3, 1908.

or above ground of electricity and electric, pneumatic, hydraulic or other power or force and therewith to convey, conduct, furnish or receive such electricity, current, power or force to or from any company or companies at any place through, over, along or across any public highway, bridges, viaducts, railways, watercourses or over or under any waters; provided, however, that the company shall have first obtained the consent of owners of property or of municipal corporations affected."

"To acquire by lease purchase or otherwise electricity, electric, pneumatic, hydraulic or other current, power or force and to store, use, supply, furnish, distribute, sell, lease or otherwise dispose of the same as well as electricity, current, power or force produced by the Company."

On March 21, 1903, the Syndicate above mentioned assigned their rights under the Agreement of Jan. 29, 1903, to the Electrical Development Co.* At present the Electrical Development Co. is associated with, or controlled by lease, by the Toronto Power Co.

On January 9, 1905, the Commissioners of the Queen Victoria Niagara Falls Park, entered into agreement with the Electrical Development Co., whereby the Company was to utilize the waters of the Niagara river for the development of 125,000 H.P., under terms and conditions corresponding to those in the agreement of Jan. 29, 1903. This agreement, however, was not ratified by the Lieutenant-Governor in Council, and, consequently, never became valid.†

PLANT.—The plant of the Electrical Development Co. (now the Toronto Power Co.) is situated above the falls, and about midway between the headworks of the Ontario Power Co. and of the Canadian Niagara Power Co. A wheel-pit about 400 ft. long and 22 ft. wide contains vertical turbines. Each alternate turbine discharges into two tail-race tunnels which run parallel to the wheel-pit and, about 150 feet beyond it, unite into a main tail-race tunnel which discharges under the Horseshoe falls. The estimated velocity of flow in the discharge tunnel is about 26 feet per second.

The plant operates under an average effective head of about 135 feet, but the head is said to vary from 130 to 145 feet dependent upon conditions in the river.

Under the agreement with the Park Commissioners there is no fixed amount of water specified to be taken from the Niagara river, but the quantity of water required by the complete plant has been computed to be about 11,200 cubic feet per second. This quantity has been allotted under recommendation of the International Waterways Commission.

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* Confirmed by special Act of the Ontario Legislature, 5 Ed. VII, chap. 12.

† See *Twentieth Annual Report*, Q. V. N. F. P. Commission, 1905, p. 14.

The quantity of power developed by the Electrical Development Co. which may be imported into the United States under the Burton Act (exclusive of the amount which may be imported under revocable permits) is 46,000 H.P.

The plans of the company provide for 11 units each of a nominal capacity of 12,500 H.P.,—a total of 137,500 H.P.—making the nominal capacity of the plant 125,000 H.P., when one unit is regarded as a spare.*

TERMS OF LICENSE.—For the first 10,000, or less, electrical horse-power, the Company pays a yearly rental (payable half-yearly) of $15,000. For each additional electrical horse-power "generated and used, and sold or disposed of," the annual rental for each horse-power shall be,

From 10,000 H.P. to 20,000 H.P.	$1.00 per H.P.
From 20,000 H.P. to 30,000 H.P.	.75 per H.P.
From 30,000 H.P. and over	.50 per H.P.

That is to say, by way of example, the gross yearly rental of 40,000 electrical horse-power would be $37,500.

The average amount of power developed throughout each six months' period beginning with Feb. 1, 1908, has been as follows:

Feb. 1st, 1908	11,324 H.P.
Aug. 1st, 1908	13,208 H.P.
Feb. 1st, 1909	13,575 H.P.
Aug. 1st, 1909	18,212 H.P.
Feb. 1st, 1910	17,579 H.P.
Aug. 1st, 1910	18,863 H.P.
Feb. 1st, 1911	22,157 H.P.

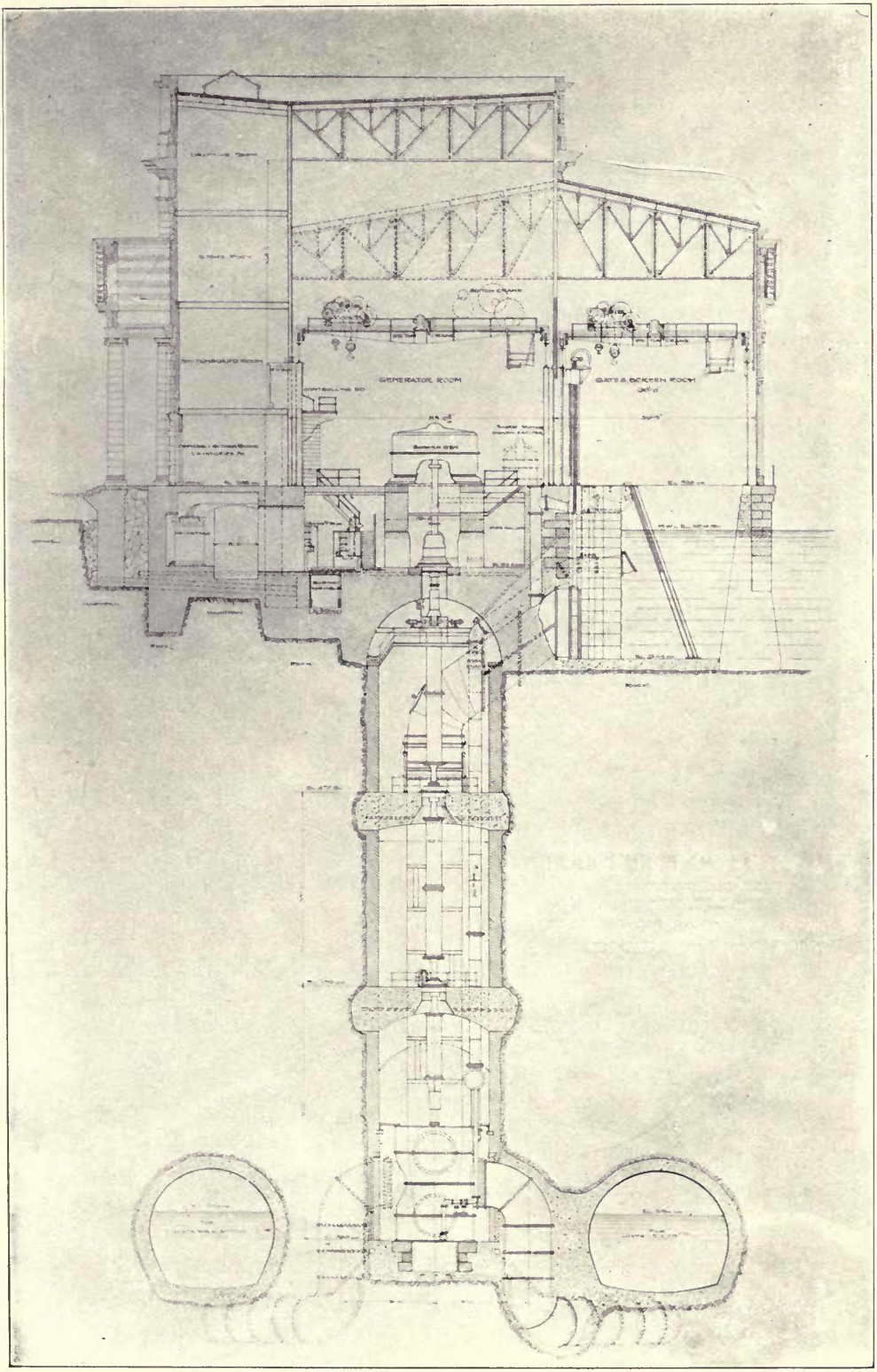
The license granted is for a term of 50 years from Feb. 1, 1903. The Syndicate has the option to make three renewals of the lease for a term of 20 years each, thus making 110 years in all. The Lieutenant-Governor in Council has the option, under specified notice, to require the Syndicate to continue its operations for a further term of 20 years, thus making in all 130 years. Provision is made for the readjustment of rentals at each renewal period.

Toronto and Niagara Power Company

This Company was incorporated by James Ross, Montreal, and William Mackenzie, Henry M. Pellatt, Frederick Nicholls and Samuel G. Beatty, Toronto†. It is granted wide powers appertaining to the development, transmission and distribution of electric and other power, among them being the following:

*The last unit installed has a nominal capacity of 13,400 H.P.

† Dominion Statutes, 2 Ed. VII, chap. 107.



Courtesy Electrical Development Co.

CROSS-SECTIONAL VIEW OF THE POWER HOUSE AND WHEEL-PIT OF THE ELECTRICAL DEVELOPMENT CO. AT NIAGARA FALLS

"The company may supply hydraulic, electric or other power by means of cables, machinery or other appliances, and at such rates and upon such conditions as are agreed upon, and the Company may contract with any company or person having erected or having power to erect a bridge or viaduct across the Niagara River, for permission, upon such terms as are agreed upon, to carry one or more wires for electric power or other purpose upon and over the said bridge or viaduct towards the United States shore of the Niagara River, and connect the same with the wires of any electric or other company in the United States, for the purpose of enabling the Company to furnish and guarantee continuous power for the uses proposed to be served by the Company, and may contract with such company to work the said electric or other power jointly, or may acquire any existing contract of such character."

It is this company which transmits to Toronto, the power developed by the Toronto Power Co.

Toronto Power Company

On Nov. 14, 1890, the Toronto and Mimico Electric Railway and Light Co., Ltd., was incorporated by Ontario Letters Patent. The name was changed to the Toronto and Mimico Railway Co. Ltd.,* and on Feb. 7, 1908, by Supplementary Letters Patent, additional powers relating to the distribution of electric and other power were conferred upon the Company. On Mar. 20, 1908, by order of the Lieutenant-Governor, the name was again changed to the Toronto Power Co. Ltd.†

The Company, at present, is said to control, by leases, both the Electrical Development, Co. and the Toronto and Niagara Power Co.

International Railway Co.

On Dec. 4, 1891, the Commissioners of the Queen Victoria Niagara Falls Park entered into an agreement with a syndicate of Canadian capitalists for the construction and operation of an electric railway on the west bank of the Niagara river, from the village of Queenston to the village of Chippawa. This agreement states that

"The Commissioners will assent to an arrangement being made between the Company and the municipal corporation of the Town of Niagara Falls for the supply to the Company of power for working the railway and the machinery necessary to operate and light the railway, and if an agreement satisfactory to the Company cannot be made between the Company and the said municipal corporation, the Commissioners will grant to the Company such necessary right as will enable them to procure from the waters above the Falls the power required for the above purposes."‡

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* Ontario Statutes, 3 Ed. VII, chap. 118.

† See also Supplementary Letter Patent, June 3rd, 1908,(Ontario)

‡ See *Annual Report*, Q. V. N. F. Park Commissioners, 1891, p. 8.

This agreement was confirmed, and a company, under title of the Niagara Falls Park and River Railway Company, was incorporated by Act of the Ontario Legislature.*

On May 3, 1894, the Park Commissioners, the Niagara Falls Suspension Bridge Co., and the Niagara Falls Park and River Railway Co., entered into an agreement regarding their respective properties and construction rights. This agreement was confirmed by Act of the Dominion Government,** and by it the Niagara Falls Suspension Bridge Co., was empowered to

> "Lay and maintain along, upon or under any new bridge hereafter built by it, and the approaches thereto, gas pipes and also wires, cables or other appliances for the transmission of electricity or other motive power."

In 1900, the Buffalo Railway Co., incorporated by the state of New York, and owning and operating electric railways in the cities of Buffalo, Tonawanda, Lockport, Niagara Falls, N.Y., and in the county of Niagara, N.Y., obtained Canadian incorporation under a Dominion Act,† Under this Act the Buffalo Railway Co.

> "May purchase the entire assets and acquire, undertake and exercise the whole, or any part, of the business, undertaking, property and liabilities, and the name, franchise, and good-will of the Niagara Falls Park and River Railway Company, the Queenston Suspension Bridge Company, the Queenston Heights Bridge Company, the Clifton Suspension Bridge Company, or of any of such companies."

This Act was followed by an Act of the Ontario Legislature, 1 Ed. VII, chap. 86 (15th April 1901), which is stated to be

> "Confirmatory legislation in order to remove any possible constitutional doubt or question respecting the purchase by the Buffalo Railway Company as under the Canadian Act 63-64 Vict. chap. 54. In this Act, however, the original Act (55 Vict. chap. 96) was amended by striking out the words 'to work and light the said railway' and substituting therefor the words 'the purposes of any railway company which purchases the franchises of this company.'"

On May 15, 1902, the Buffalo Railway Co. obtained an amendment to 63-64 Vict., chap. 54, changing the name to the International Railway Co.‡ By Ontario Act, 2 Ed. VII, chap. 12, Sec. 30, the name "International Railway Company" is also substituted for the name "Buffalo Railway Company" wherever the same appears in the Statute of Ontario, 1 Ed. VII, chap. 86. The International Railway Company is, therefore, seen to be

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* 55 Vict., chap. 96. See also 57 Vict., chap. 13.

** 57-58 Vict., chap. 98.

† 63-64 Vict., chap. 54.

‡ Dominion Statutes, 2 Ed. VII, chap. 43.

an amalgamation of several other companies. In October, 1903, the International Railway Co. applied to the Commissioners for approval of plans which involved the conveyance of

> "Electric power to the American side of the Niagara River to operate in whole or in part the extensive electric railway system of the company in the State of New York."

This request was not granted by the Commissioners, but was referred by them to the Government. *

The power plant of the Niagara Falls Park and River Railway Co. is situated within the Queen Victoria Niagara Falls Park. It operates under a head of from 60 to 68 feet which could be increased by about 100 feet. The quantity of water which the Company may take is not defined in the agreements, but physically, it would depend upon the velocity of flow that could be maintained through the intake works. The forebay is of irregular shape, about 62½ feet wide in its most restricted section. It slopes 6 inches in about 150 feet, attaining a depth of 5½ feet at the power house end. The intake is to be "not less than 5 feet" deep.

The quantity of water required for the complete plant has been computed to be about 1,500 cubic feet per second, and this quantity has been allotted under recommendation of the International Waterways Commission. The plant capacity for the apportionment of water was taken at 8,000 H.P. The Report of the Park Commissioners refers to a possible development of 10,000 H.P., and also to a possible future development of 20,000 H.P., if the wheel-pit is made deeper.

The quantity of power developed by the Niagara Falls Park and River Railway Co. which may be imported into the United States under the Burton Act (exclusive of the amount which may be imported under revocable permits) is 1,500 H.P. This quantity is held in reserve until a settlement is had of certain questions relating to the powers of the Company.

Terms of Lease.—The terms for power rental in the case of the Niagara Falls Park and River division of the International Railway are included in the rental of $10,000 per annum, which includes the right to run through the Park.†

The lease is for a period of forty years from Sept. 1st, 1892, and, subject to certain conditions, it may be extended for a further period of twenty years.‡

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* See *Annual Report* Q. V. N. F. Park Commissioners, 1905, p. 14, and p. 27 *et seq;* also the *Report of the International Waterways Commission; Sessional Papers* (Can.) No. 19a, 1907, p. 271.

† See Ontario Statutes, 1892, Chap. 96, Schedule B to the Agreement, clause 14.

‡ See, Ibid, Schedule B, clauses 16-17; also 1 Ed. VII, chap. 86, sec. 3, (Ontario)

Niagara Falls Water Works The intake works of the city of Niagara Falls, (Ontario) water works, are used conjointly with the intake works of the International Railway Co. The intake is a circular opening 6½ feet in diameter and, at times, the surface of the water is below the top of the opening. The head is about 25 feet, and is used to develop 500 H.P. for civic pumping purposes.

The Mather Bridge and Power Co. This company* does not intend to withdraw or divert any water from the Niagara river, but proposes to erect a bridge over the Niagara river from Fort Erie to Buffalo and it is further proposed to erect, for power purposes, "under such spans of this bridge, as shall be approved by the Governor in Council, a wheel or wheels not more than two hundred feet in length and forty feet in diameter."

By subsequent acts, the time limit for the construction of the works has been extended until five years from June 26, 1906.

Niagara-Welland Power Co. On July 23, 1894,† the Welland Power and Supply Canal Co., Ltd., for the development of power was granted rights by which

> "The Company may construct, equip, maintain and operate a canal and hydraulic raceway from some point in the Welland River, within five miles from its junction with the Niagara River, to a point or points on or under the Niagara escarpment at or near the township line between the townships of Stamford and Thorold, in the county of Welland, or in the township of Grantham, in the county of Lincoln, with such raceways or extensions of the said canal and hydraulic raceway through the said township of Grantham or the township of Niagara as are necessary to carry off the surplus water from the said canal and hydraulic raceway to Lake Ontario, with all such works, dams and wing dams, docks, sluices, conduits, accessories and buildings as are necessary to give full effect to the intent of this Act; with power to dredge, deepen or widen the Chippewa Creek or Welland River from its mouth to the point of intersection of the said canal with the Chippewa Creek or Welland River if so found expedient for the purpose of the Company: . . "

On July 10, 1899, the name was changed to the Niagara-Welland Power Co., Ltd.‡ On May 16, 1905, the company secured the additional power to engage in the business of transportation.** By various acts, the

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* Dominion Charter, 60 Vict., chap. 13; see also 1 Ed. VII, chap. 106; 6 Ed. VII, chap. 124, (Canada)

† Dominion Statutes, 57-58 Vict., chap. 102.

‡ Dominion Statutes, 62–63 Vict., chap. 129.

** Dominion Statutes, 4-5 Ed. VII, chap. 133; 8-9 Ed. VII, chap. 114.

time limit for the construction of the works has been extended to five years from May 1, 1910.*

North American Canal Co. This company† was authorized, amongst other things,

> "To lay out, construct, maintain and operate a canal from some point on Lake Erie at or near Port Colborne to some point on Lake Ontario at or near Port Dalhousie, or to some point on the Niagara River at or near Queenston."

The navigable channel was to be 20 feet deep and of sufficient width to permit two of the largest vessels drawing 20 feet each to pass each other at full speed. The works were to be completed within ten years from the date of the passing of the Act. The time limit for the execution of the construction works under this Act has expired.

Erie Ontario Power Co. This company‡ was incorporated under a Dominion charter on June 25, 1903, and is granted rights for the development, transmission and distribution of power as follows:

> "The Company may construct, maintain and operate a watercourse and raceway, from some point or points on the Grand River, or Lake Erie, at or near the mouth of Grand River, northerly to a point on the Jordan River, thence to lake Ontario; and also may construct, maintain and operate all necessary works, dams and wing dams, docks, sluices and conduits, accessories and buildings; and may construct a culvert of sufficient and necessary proportions to carry such watercourse and raceway underneath the Welland canal feeder, and may construct a sufficient aqueduct over the Welland River, and may dredge, deepen and widen the Jordan river from the point of intersection with the said watercourse and raceway to Lake Ontario, for the purposes of the Company, and may use the waters of Lake Erie or the Grand River in such quantities as are requisite and necessary for the efficient and satisfactory running and operating of the said works and for the purposes aforesaid; Provided that the undertakings of the Company shall in no way interfere with the undertakings of the Hamilton and Lake Erie Power Company."

On June 1st, 1906, the time limit for the execution of the construction work was extended for five years from 1st June, 1906.**

Jordan-Erie Power Co. The Hamilton and Lake Erie Power Co., was incorporated on July 22, 1895, under a Dominion charter.§ The company is granted powers for the development, transmission and distribution of electrical energy.

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* Dominion Statutes, 60-61 Vict., chap. 73; 3 Ed. VII, chap. 163; 4–5 Ed. VII., chap. 133; 8–9 Ed. VII., chap. 114.

† Dominion Incorporation, 56 Vict., chap. 66.

‡ 3 Ed. VII., chap. 119.

** 6 Ed. VII., chap. 91. (Canada)

§ 58–59 Vict., chap. 78.

"The company may construct, equip, maintain and operate a watercourse and raceway from some point on the Welland River not nearer than twelve miles, nor more than thirty miles from its junction with the Niagara River, northerly, to a point on the Jordan River, thence to lake Ontario;.....with power to dredge, deepen and widen the said Welland River, and also to dredge, deepen and widen the Jordan River from the point of intersection with the said watercourse and raceway to Lake Ontario if so found expedient for the purposes of the company; and the company may use the waters of Lake Erie, and the Niagara River, by way of the Welland River, in such quantities as are requisite and necessary for the efficient and satisfactory running of the said works, and for the purposes aforesaid."

On June 13, 1898, an extension of the time limit for the commencement and completion of the works was obtained, and on June 25, 1903, the name was changed to the Jordan Light and Power Co. Certain amendments and a further extension of the time limit for the execution of the construction works were authorized at the same time.*

On Nov. 25, 1903, the Erie and Ontario Development Co. Ltd., was incorporated under the Dominion Companies Act. The charter empowered the Company to develop, transmit and distribute electrical power and to hold stock in and to amalgamate with the Jordan Light, Heat and Power Co. On November 27th, 1906, the Jordan Light, Heat and Power Co. amalgamated with the Erie and Ontario Development Co. Ltd., under the corporate name of the Jordan-Erie Power Co. The terms of the amalgamation are set forth in the incorporating Act† wherein it is stated that

"The Company may construct and operate its watercourse and raceway from Lake Erie and may take its water from lake Erie direct as well as by way of the Niagara and Welland rivers, as provided in section 4 of the Act incorporating The Jordan Light, Heat and Power Company, and for that purpose may construct a watercourse and raceway from a point on Lake Erie in the township of Wainfleet in the County of Welland, running thence northerly to and into the Welland River; thence northerly from the Welland river through the township of Gainsborough in the County of Lincoln, the township of Pelham, in the County of Welland and the township of Louth in the County of Lincoln to Lake Ontario, utilizing for a portion of the route the line of the Jordan Light, Heat and Power Company, as shown on the plan of that Company's works approved by order in council, dated the seventh day of July, A.D. 1900, and for another portion of the route the line of the Erie and Ontario Development Company, Limited; and utilizing parts of Fifteen-Mile Creek and of Sixteen-Mile Creek as reservoirs for the Company's water supply, and also with power to deepen and dredge the south branch of the Welland River."

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* Dominion Statutes, 61 Vict., chap. 104; 3 Ed. VII., chap. 136.

† Dominion Statutes, 6–7 Ed. VII., chap. 98.

The time for the commencement and completion of the works was extended for three and five years, respectively, from April 27, 1907.*

The Hamilton Cataract Power Co.

On July 9, 1896, Ontario Letters Patent† were granted the Cataract Power Co. of Hamilton, Ltd., by which the Company was empowered

(a) To manufacture, sell or purchase electric power whether generated by water-power, steam or other force, and to apply the same in any of the Arts or Sciences or in the manufacture of any article or in any condition in which the use of electricity is employed.

(b) To purchase any lands or purchase or erect any buildings, wharves, bridges or other structures that the company may require or to sell any of them, and

(c) To promote any industry or enterprise that may be deemed advantageous to the company, provided it is one to or from which the company may derive or supply power or the means of using or producing it under the name of "The Cataract Power Company of Hamilton, Limited."

The Letters Patent above mentioned were confirmed on Jan. 17, 1898,‡ and the Ontario Government enlarged the powers of the company; and, also, subject to provisions relating to the rights of navigation and to the rights of the city of St. Catharines and other corporations, enacted that the Company

"May construct, equip, maintain and operate a canal and hydraulic raceway from a point at or near Allanburg to some point on the Welland River, at or within two miles of the Village of Port Robinson, as an extension of their canal or raceway from the Niagara escarpment near the waterfall, known as Decew's Falls in the township of Grantham, with all such works, dams, docks, sluices, conduits and accessories as may be neccessary."

On Aug. 12, 1899, by Order in Council, the name of the company was changed to the Hamilton Electric Light and Cataract Power Co., Ltd., and, on the same date, and again, on 21st of September, 1899, supplementary Letters Patent were issued increasing its powers.

On Feb. 5, 1903, Ontario Letters Patent were granted to the Hamilton Cataract Power, Light and Traction Co., Ltd., allowing it to enter into

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* For non-interference of proposed works of the Erie Ontario Power Company with the proposed works of the Hamilton and Lake Erie Power Company, see 3 Ed. VII, chap. 119, sec. 8, Dominion Statutes. For legislation empowering the Canadian Steel Company to hold stock in the Hamilton and Lake Erie Power Company, or any other power company, see 63-64 Vict. chap. 94, sec. 11, Dominion Statutes.

† Supplementary Letters Patent, were granted, May 6, 1897.

‡ Ontario Statutes, 61 Vict., chap. 68.

an agreement with the Hamilton Electric Light and Cataract Power Co., for the acquirement of their rights, powers, franchises, assets, etc.

In part, the powers granted the Company are as follows:

(a) To acquire by lease, purchase, or otherwise and to utilize and develop water-powers and other powers for the production of electric, pneumatic, hydraulic, or other power, or force;

(b) To construct, or acquire by lease, purchase, or otherwise and to operate works and appliances for the production of electric, pneumatic, hydraulic, or other power, or force, also works and appliances for the delivery and transmission under or above ground of electric, pneumatic, hydraulic or other power or force;

(c) To acquire by lease, purchase or otherwise electric pneumatic, hydraulic, or other power, or force and to use, sell, lease or otherwise dispose of the same and of power and force produced by the company;

(d) To construct, or acquire by lease, purchase, or otherwise and to operate in connection with the works, lines and business of the company and, for the purposes thereof, lines of telegraph or telephone or other works and means of communication;

(e) To aid by way of bonus, loan, guarantee, or otherwise any industry or enterprise using or agreeing to use power supplied by the Company, or supplying, or agreeing to supply power to the company and to acquire stock in any corporation carrying on or having power to carry on any such industry or enterprise, and the bonds, debentures or other securities of and any indebtedness of any such corporation and to act as agent, or manager of any such industry enterprise or corporation, and

(f) To sell, lease, or otherwise dispose of from time to time any of the assets or property of the company.

On May 22, 1904, the Ontario Government by special Act* confirmed the Letters Patent of Feb. 5, 1903, and, also, certain agreements. Schedule B of the Act gives the agreement of Feb. 21, 1903, for the purchase of the Hamilton Electric Light and Cataract Power Co.†

Water Rights.—The Company, subject to non-interference with navigation, have leases for, or hold in fee simple, rights to use 1,100 cubic feet of water per second from the lake Eric level of the Welland

* 3 Ed. VII., chap. 122.

† For other data respecting the H. C. P. L. & T. Co. Ltd., see *Ontario Gazette* 1896, p. 629; 1897, p. 901 and p. 1343; 1898, p. 1021; 1899, p. 781 and p. 1030. 62 Vict. (2) chap. 95, (Ont). 4 Ed. VII, chap. 99, (Ont.)

canal. These rights, which consist principally of leases granted by the Department of Railways and Canals, Ottawa, may be briefly set forth as follows:

Lease No. 14816, of Dec. 31, 1902, confirmed by Orders in Council, 6th and 19th Dec., 1902, grants the Hamilton Electric Light and Cataract Power Co. Ltd., the right to divert 700 cubic feet of water per second from the Welland canal. The rental is $30 per cubic foot per annum. The lease expires Dec. 31, 1923, but is renewable for two periods of 21 years each, after which it may be further extended at the option of the Governor General in Council.

Lease No. 14816, cancels an earlier lease No. 12699 of October 8, 1897.

Lease No. 16143 of March 31, 1906, confirmed by Order in Council Mar. 8. 1906, grants the Hamilton Cataract Power, Light and Traction Co. Ltd., 300 cubic feet of water per second additional to the 700 c.f.s. granted in lease No. 14816. The rental is $30 per cubic foot per annum. The period of the lease corresponds to that of lease No. 14816.

Lease No. 18181—The Department of Railways and Canals, Ottawa, leased to one named Robert Cooper 100 cubic feet of water per second at an annual rental of $413 per year. On Dec. 15, 1909, under Assigned Lease, No. 18055, of Nov. 20, 1909, Cooper assigns his right to 100 cubic feet per second, at the Allanburg weir, to the H. C. P. L. & T. Company. The Company for these water rights, gives Cooper a stipulated quantity of electric energy.

Townsend water rights—One named Townsend had water rights on a small stream, which rights were interfered with by the construction of the Welland canal, and in consequence of such interference the Department of Railways and Canals granted Townsend the right to divert 10 cubic feet of water per second from the Welland canal. Townsend's property, with the accompanying water rights, was acquired by the H. C. P. L. & T. Company, and the right to the 10 cubic feet of water per second now belongs to the Company.

City of St. Catharines—A lease No. 16058 (superseding No. 13011), from the Department of Railways and Canals was granted to the city of St. Catharines to take 50 cubic feet of water per second from the Welland canal at an annual rental of $500 per annum. In building the storage reservoir of the H. C. L. P. & T. Company's power house the river basin from which the city of St. Catharines derived its water supply was submerged, in consequence of which the Company have entered into agreement with the city of St. Catharines, by which the City's 50 cubic feet of water per second enter, and are withdrawn from the storage reservoir of the Company.

PLANT.—The Hamilton Cataract, Power, Light & Traction Company, Limited, operate their plant under a static head of 263 ft., and, under full load, each penstock has an operating head of 256 feet.

The maximum winter load (1910) is about 15,000 to 22,000 K.W.

The Company has a storage reservoir of area about 500 acres, affording it is stated, a supply of water for 50,000 H.P. for thirty hours.

On account of utilizing its high head, the Company obtains much more power per cubic foot of water than any other company utilizing the waters of lake Erie.

Dominion Power and Transmission Co., Ltd.

This Company* was incorporated under Dominion charter, Jan. 11, 1907, and an Ontario license (under 63 Victoria, chapter 24) was issued on Feb. 11, 1907. The objects of the company, briefly summarized, are:

> "To develop electric, steam, pneumatic, hydraulic or other powers or forces, to construct all plant necessary for such purposes; to purchase such power or force from others; to treat by electrolytic or other electric process ores, minerals, etc., and to instal all plant necessary for that purpose; to deal in logs, timber, wood and metals and manufacture articles therefrom, to carry on the business of a land improvement company; to acquire the assets, business, property and rights of other companies carrying on any business similar to this company, to carry on any other business which may be incidental to the carrying out of the objects for which the Company was incorporated."

American Companies at Niagara

A number of companies have been incorporated with United States charters to take water from the Niagara river and lake Erie. A list of these companies follows, together with a statement of the principal rights and privileges granted each:†

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*The Dominion Power and Transmission Co. controls or operates the Hamilton Terminal Co.; Hamilton Grimsby & Beamsville Electric Railway Co.; Hamilton Cataract Power, Light and Traction Co.; Hamilton Electric Light & Cataract Power Co.; Brantford & Hamilton Electric Railway Co.; Brantford Electric & Operating Co.; Welland Electric Railway Co.; Western Counties Electric Co.; Hamilton & Dundas Street Railway Co.; Hamilton Radial Electric Railway Co.; Hamilton Electric Light & Power Co.; Dundas Electric Co.; Lincoln Electric Light & Power Co.

†For further data respecting these companies, consult U.S. *War Document*, No. 289; also booklet published by the Local Committee of the Canadian Society of Civil Engineers, entitled, "Presented by the Local Committee of the Canadian Society of Civil Engineers," at Niagara Falls, Sept. 27th, 1904; also Canada, *Sessional Papers*, No. 19a, p. 244, *et seq.*; also pp. 260–261; see also, Transportation Corporations Law, in *Consolidated Laws of the State of New York*, 1909, Vol. V., p. 4385, f.f.; or in the Laws of 1909, p. 219.

NIAGARA FALLS HYDRAULIC POWER & MANUFACTURING COMPANY.—This company, under its present name was organized under the general laws of the state of New York in 1877, and in 1881 established the first station at Niagara falls, for supplying electricity for lighting as a commercial enterprise. The company's right to divert water from the Niagara river having been questioned in 1895, the New York State Legislature passed legislation confirming its right to divert water, generate power and sell the same.* This right was not restricted as to time but the amount of water that could be taken was limited to that which could be drawn off by a canal 100 feet wide and of an average depth of 14 feet. It is computed that the works now under construction require about 9,500 cubic feet per second; but works could be constructed under different plans to use a much greater quantity of water.

NIAGARA FALLS POWER COMPANY.—The initial rights granted this company were conferred in 1886 by the New York State Legislature.† It is authorized to take water sufficient to generate 200,000 H.P., computed to be about 17,200 cubic feet per second. Its franchise is for fifty years from March 31, 1886.

THE NIAGARA COUNTY IRRIGATION AND WATER SUPPLY COMPANY, incorporated in 1891 by New York state, may divert water from the Niagara river to supply Lewiston and other villages, and may lease and sell water for manufacturing and other purposes.

THE NIAGARA POWER AND DEVELOPMENT COMPANY which was incorporated by New York state in 1893, is authorized to build a town, equip plants for the public utilities therein, and divert water from lake Erie and the Niagara river for all purposes except for motive power for factories.

THE NIAGARA, LOCKPORT AND ONTARIO POWER COMPANY, incorporated in 1894, was empowered to take water from the Niagara river for supplying water and electricity to Lockport and other cities. In 1904 it failed to secure legislation to perpetuate its privileges and has since been operating as a transmission company.

THE NIAGARA GORGE POWER COMPANY‡ was incorporated in 1905 to generate, transmit and sell electricity in the counties, cities, towns and villages of the state of New York.

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* Laws of 1896, chap. 968.

†See Laws of 1886, chap. 83 and 489; 1889, chap. 109; 1891, chap. 253; 1892, chap. 513; 1893, chap. 477.

‡ Pursuant to provisions of the Transportation Corporations Law, Article VI.

THE LOWER NIAGARA RIVER POWER AND WATER SUPPLY COMPANY is empowered to divert sufficient water from the Niagara river to produce 200,000 H.P. It was incorporated in 1902 under special act* of the state of New York and its term of existence is for one hundred years.

THE CATARACT POWER AND CONDUIT COMPANY was organized in 1896.† It is controlled by the Niagara Falls Power Company and has the exclusive right within the city of Buffalo to receive, use and transmit electricity, power, light and heat; also to supply Niagara falls power to the Buffalo General Electric Company and the International Railway Company.

THE NIAGARA FALLS ELECTRICAL TRANSMISSION COMPANY was incorporated by New York state in 1905.† It is controlled by the Electrical Development Company of Ontario, Limited, and has a franchise to distribute light, heat and power in Tonawanda, Lockport, Pendleton, Holley, Royalton, North Tonawanda, Medina and Sweden.

The following companies were granted privileges to divert water from the Niagara river but have done no construction work: Lockport Water Supply Company, Lewiston Water Supply Company, Buffalo and Niagara Power and Drainage Company.

General Conditions Governing Power Development at Niagara

From an economic standpoint the power possibilities of the Niagara falls and river constitute to-day the most important hydro-electric power site in the world. The process of depletion of the known coal fields of the United States—especially the anthracite coal beds of Pennsylvania—will tend, in the near future, to cause the æsthetic claims made on behalf of the scenic beauty of the Niagara falls and rapids to yield before possible aggressive demands made by companies to utilize the waters discharging from lake Erie. It is noteworthy that many of the charters already granted companies for power development are kept alive, even though, as yet, no construction works have been begun.

Remarkable Regularity of Flow

Marvellous is the regulated flow of water from the Great lakes, as it exists under the laws of the Creator. Referring to this natural regulation of flow, the Joint International Waterways Commissioners, in 1910, reported that "no work of man ever approached, or ever will approach, this perfection of regulation," and they add that man "may disturb it, making it less uniform." The conservation, therefore, of this natural uniformity of flow is a matter

*Laws of state of New York, 1902; chap. 539; see also, under *Power of the Lower Niagara river*, below.

†Under Transportation Corporations Law, *Consolidated Laws of the State of New York*, 1909, Vol. 5, p. 4385, f.f.

for national concern, and the public at large should have an intelligent appreciation of the menace that exists in unduly utilizing the waters of the Great Lakes system whether at Niagara, the Long Sault rapids, Cedar rapids, or elsewhere, for purposes of power development.

The time is coming when people will see that the amount of water which would naturally course the entire length of Niagara's bed, and which may, even temporarily, be diverted for power purposes without proving to be a serious menace to Nature's balancing of the levels of the Great lakes, is much smaller than is popularly supposed. Some exceptional natural phenomena already seem to be manifesting themselves in the Great Lakes system. What may be the results when even all the water already authorized for diversion is in service, the future alone will disclose. It would be a wise precaution, when granting water privileges on a river, say, like the Niagara river, if the governments interested reserved the power to demand that waters diverted from a river must, if so required, be temporarily returned to the river. Such a course would increase the flow and thereby assist in averting critical conditions that might arise, as, for example, a dangerous ice jam which might be broken up by the agency of an increased flow of water taking place during the formative stages of the jam.

Physical Factors of Lake Erie

The Niagara river drains an area, including lake surface, of 254,708 square miles. The lake surface area is 87,845 square miles, making the ratio of lake to drainage area as 1 to 2.9.

In the Great Lakes system there is a regular annual variation in levels due to difference in rainfall, evaporation, and run-off, the water level being highest in mid-summer and lowest in mid-winter.* The levels are affected also by the greater or less severity of the winter and by the consequent greater or less decrease in the discharging capacity of the outlets by ice. The interval of time required for an increasing supply to show its effect upon the level of lake Erie is about 76 days, and for a decreasing supply it is about 132 days.

The extreme variation of level of lake Erie during the period 1860–1907 is 3.89 feet, with a maximum range in one year (1892) of 2.28 feet, a minimum range in one year (1895) of .87 feet, and an annual average range of 1.56 feet.

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*The physical factors appertaining to the levels of the Great Lakes system have been published in two very able reports, one, the *Report of the Deep Waterways Commission*, 1900, the other the recent comprehensive *Report of the International Waterways Commission on the Regulation of Lake Erie*. These Reports have been freely quoted in the following remarks, which are given in order that a better appreciation may be had as to the main factors which determine the power possibilities of the Niagara river.

The amount of water which lake Erie discharges through the Niagara river is a variable quantity and depends upon the elevation of the water surface, or, as it is termed, the *stage*, of the lake. For the Great Lakes system it is customary to give the stages of the respective bodies of water above a fixed datum. Mean tide water at New York is the datum usually selected.

Consider an illustration. A variation in the stage of lake Erie of a single foot, at Buffalo Lighthouse, Buffalo, corresponds to a difference in the rate of the discharge from the lake of from twenty to twenty-five thousand cubic feet of water per second. The increments of discharge per foot change in stage vary for different sections of the river. They are expressed in cubic feet per second, at Buffalo Lighthouse, as follows:

Stage	Increment in c.f.s.
572.67 (mean)	23,400
570–571	19,600
571–572	21,400
572–573	23,200
573–574	25,100

The knowledge such data conveys is, that if the water level of lake Erie, at Buffalo Lighthouse, for example, is 570 feet above mean tide level at New York, and the level rises to 571 feet, then, the Niagara river will discharge at the rate of 19,600 cubic feet of water per second more than it was discharging at the 570 foot stage. If, next, the stage rises from 571 to 572 feet, then the discharge rate becomes 21,400 cubic feet per second greater than it was at the 571 foot stage.

The bearing which such facts have upon the question of power development is, that the horse-power available at any specified time, at, say, Niagara falls, depends upon the quantity of water flowing in the Niagara river at that time, and, as has just been pointed out, this quantity depends upon the stage, or level, of the water in lake Erie.

In addition to the monthly, yearly or other periodic changes, variations in the level of the lake's surface, due to winds and to change of barometric pressure, are frequent and irregular, and at times violent. Variations of more than 6 inches are very common, often occurring hourly for many hours in succession, while variations of 2 or 3 feet within an hour are not uncommon. It sometimes happens that the stage varies as much as 7 or 8 feet in one day. Storms raise the water level at Buffalo several feet higher than normal, and lower it at Amherstburg, by a like amount; the difference of level between the two ends of the lake in extreme cases having been as great as 15 feet.*

*See *Report of the International Waterways Commission on the Regulation of Lake Erie*, p. 11; also p. 17.

DISCHARGE OF NIAGARA RIVER.—The discharge of the Niagara river has been determined by measurements taken at the International Bridge located at Buffalo, N.Y., and at a point about 1,800 feet down stream at the "Open Section." Measurements were begun in 1897 and are being carried on by the engineering staff of the United States Lake Survey. The maximum monthly mean discharge from lake Erie, 257,800 cubic feet per second, equivalent to a depth of 2.44 feet on the lake, occurred in June, 1876. The minimum, 168,700 cubic feet per second, equivalent to a depth of 1.60 feet on lake surface, occurred in March, 1896. The average discharge of the Niagara river during the period 1860–1907 is 212,200 cubic feet per second.

From 1860 to 1907 the greatest excess average for any one month was for June, 1876, being 45,600 c.f.s., or twenty-one per cent.; the greatest excess average for any one year was for 1876, being 26,500 c.f.s., or twelve per cent.; the greatest deficiency average for any one month was for March, 1896, being 43,500 c.f.s., or twenty-one per cent.; the greatest deficiency average for any one year was for 1895, being 31,800 c.f.s., or fifteen per cent.*

POWER POSSIBILITIES OF NIAGARA FALLS.—Many statements of a misleading character—no doubt, sometimes, through ignorance—have been published regarding the water-power possibilities of Niagara falls. *Theoretical* quantities of available horse-power have been presented to the attention of the public, while quantities of *actually developed* horse-power have been the units in which power companies have required their concessions from the government. Comparisons should be made with corresponding units.

Under conditions of average discharge the Niagara river, from lake Erie to lake Ontario, with its total fall of about 325 feet, would, theoreti-

*The most recent and extensive published data relating to the Niagara river will be found in the *Report of the International Waterways Commission on the Regulation of Lake Erie*, Ottawa, 1910. The discharge formula is given on pages 48–49; for the average discharge in cubic feet per second for each month from 1860 to 1907 inclusive see Table No. 21; the supply factors for Lake Erie are given in Table No. 26; the mean monthly supply factors in Tables Nos. 28 and 31. These various data are shown graphically upon plates. Plate 1 shows the monthly mean stage of lakes Superior, Michigan, Huron, St. Clair, Erie and Ontario from 1860 to 1907 inclusive.

In the *Report of the Deep Waterways Commission*, 1900, Washington, 1900, Part I, the areas of the lake surfaces and watersheds, data as to rainfall and deductions as to the amount of evaporation will be found on pages 276–7; for Niagara discharge see p. 278, also p. 286. Appendix No. 7, pages 298–321, is a report on *Niagara River Discharge*, by C. B. Stewart. Plate 81 gives curves showing *Lake Ontario Water Levels and Niagara river Discharge from 1865 to 1898 inclusive:* Plate 89 gives the *Discharge Curve of Niagara River at Buffalo, N.Y.*

In the Report of the Chief of Engineers, U.S. Army for 1900, see report of E. E. Haskell, pages 5322–5326; also report of F. C. Shenehon, pages 5326–5361, (Summary, p. 5360); also, in Report 1903, report of E. S. Wheeler, pages 2855–2883 (Lake Erie, pp. 2875–76); also, in Report 1909, *re* Niagara River, see pp. 931–941, and pp. 2477–2507; also, in Report 1910, *re* Preservation of Niagara falls, see pp. 1050–1053, and pp. 2722–2725.

cally yield about 8,000,000 horse-power. The fall in the Niagara river from lake Erie to the surface of the water below the Falls is about 226 feet, and from the head of the rapids above the Falls (forebay of the Ontario Power Company's head works) to the foot of the Falls, about 212 feet. The Ontario Power Company operates under a normal head of about 180 feet; consequently, this company untilizes about eighty-five per cent. of the available head of 212 feet. This is a larger percentage of the total head than is utilized by other companies at Niagara. The combined efficiency of the turbines and generators constituting the large units at the Falls is about eighty per cent., so that only eighty per cent. of the eighty-five, which is sixty-eight per cent., of the possible development, is available as developed electrical horse-power. Hence, one of the first things we have to do is to cut the theoretically possible horse-power down over thirty per cent.

Again, in estimating possible available horse-power, it is customary to base the estimates upon the minimum discharge, or flow. Such is the basis employed for the estimates given in the Hydro-Electric Power Commission and many other reports. Now, if the power at Niagara falls is considered on this basis of minimum monthly discharge, then, a further reduction of twenty per cent. must be made from the horse-power totals customarily given for the Falls based upon average conditions of flow. Hence, reducing our sixty-eight per cent. by twenty per cent., we find that the developed horse-power possibly available at the Falls will be about fifty-five per cent, of the total theoretical horse-power estimated for average conditions.

It must not be forgotten, either, that it would never be possible to use all the water of the river. The ice must go by way of the Falls and not by way of the water-wheels. Just how much water must be reserved to go over the Falls in order to prevent the ice from lodging above the Falls and creating disastrous ice jam conditions, would be difficult to state. Possibly the diversions of water at present authorized may yet be found, when all is in service, to encroach upon the limits of safety.

Considered, therefore, in the most favourable light of the facts just mentioned, and from the viewpoint of the amounts of power obtained from present Niagara deveolpments, all the mean low-water discharge, with the 212 feet available at Niagara falls, would give an estimated amount of about 2,765,000 H.P. Canada's share of this would be 1,382,500 H.P.

Let us, however, view the situation from another standpoint. It has been ascertained by special investigations made of existing Niagara plants by the United States Government, that it takes about .075 of a cubic foot of water per second, to actually develop one horse-power; even on this basis, the low-water discharge of 168,700 cubic feet per second would yield at the Falls about 2,250,000 H.P., of which Canada's share

AUBREY FALL, MISSISSAGI RIVER, ONT.

Courtesy Hydro-Electric Power Commission

SIXTH FALL, WHITE RIVER, ONT.

would be 1,125,000 H.P. Franchises have already been granted, and plants partially completed, for the development on the Canadian side of the river of about 450,000 H.P. In other words, instead of 'millions' of horse-power being available, as has been sometimes stated, it appears that about half, and by all odds the better half, of Canada's usable share of Niagara falls power has already been placed under private control; and, as just intimated above, circumstances attendant upon the use of all the waters now authorized may show that ice, and other conditions, preclude the use of a further proportion of Canada's equity in the waters at Niagara falls.

We have not been dealing with theoretical quantities nor with estimates of possible actual quantities, but with quantities based upon measurements of flow and upon the percentage of the available power which the companies, who have installed operating power plants, have used under the best expert engineering advice obtainable.

Power of the Lower Niagara River.—Let us briefly consider the power possibilities of the lower Niagara river. From the head of the rapids below the Falls to the mouth of the gorge in the river there is a fall of about 94.5 feet. This is about forty-five per cent. of the head available at the locality of the Falls. Assuming that as great a proportion of the available power of the rapids is used as of the power theoretically available at the Falls, and assuming further that all the water of the river is diverted, then we would have about 1,000,000 theoretical H.P. In the portion of the river in which the fall is greatest, viz., from the head of the rapids below the Falls to the foot of Foster's flats, there is a drop of 78.5 feet. This is thirty-seven per cent. of the head available at the Falls. Upon assumptions corresponding to those just made above, the river would yield about 830,000 H.P., of which Canada's share would be 415,000 H.P.

Obviously the rights to the first 10,000 or 20,000 cubic feet of water diverted from the lower Niagara river are very much more valuable, considered from the physical standpoint, than the rights appertaining to any diversions that may subsequently be authorized.

The Lower Niagara River Power and Water Supply Company, incorporated under the laws of the state of New York and empowered by the State "not to take more water than shall be sufficient to produce 200,000 effective H.P.," has applied to the United States Federal Government for authority to utilize an amount of water not exceeding 40,000 cubic feet per second from the lower Niagara river. Reporting upon this application, the International Waterways Commission, in its Report to the United States Secretary of War, states that

> "It is our opinion that about 40,000 cubic feet per second can be diverted without perceptible injury to the rapids, and that any

amount greater than that will approach the danger line more and more nearly, according to its volume. We therefore recommend that no more than 40,000 cubic feet be diverted on both sides of the river taken together."*

Theoretically, this recommended diversion of 40,000 cubic feet per second with the head of 94.5 feet would yield about 430,000 H.P., of which Canada's share would be 215,000 H.P. With a total head of 78.5 feet to the foot of Foster's flats, 20,000 cubic feet per second would yield, theoretically, about 180,000 H.P. Owing to the difficulties of hydraulic construction and the large fluctuations in head which occur in the lower river, it would be difficult to determine just what proportion of the theoretical quantities could be obtained from a diversion on the Canadian side of 20,000 cubic feet per second.

Power sites on the rapids below the Falls are much inferior to the power sites in the vicinity of the Falls. The Commissioners of the Queen Victoria Niagara Falls Park had a report made as to the possible power sites on the Canadian side of the lower Niagara river. This Report shows a number of possible power sites using the shortest possible tunnel routes, but the estimated total of all the reported sites is considerably under 50,000 H.P.†

SUMMARY.—In conclusion it may be said that under present methods of development, and assuming *all the water* passing over the Falls to be diverted for power purposes, Canada's share of the power may be under 1,000,000 H.P. Below the Falls, using all the water and the total head of 94.5 feet, the lower river would yield for Canada's share about 450,000 H.P. These quantities are for the mean low-water discharge; for average conditions of flow they might be increased about twenty-five per cent.

If either Canada or the United States should first exercise its right to generate 500,000 H.P. from its share of the Niagara waters, then physical conditions might probably prevent the other country from actually developing all told half a million horse-power from the remaining available waters at Niagara falls.

UNDEVELOPED POWER SITES.—Many municipalities of Ontario are now dependent for their supply of electricity upon a single plant at

*See *Fourth Progress Report*, United States section, International Waterways Commission, p. 12; also *Supplementary Report*, Canadian section, International Waterways Commission. (*Sessional Papers*, Canada, No. 19a, 1910), p. 3; see also H. R. 16086 and H. R. 16748, of Committee on Rivers and Harbours, U. S. House of Representatives, *The Equities at Niagara*, pp. 41 *et seq.*

†See "Report upon the practicability of developing power for commercial purposes at various points along the West shore of the Niagara river between the Cantilever Bridge and the village of Queenstown," by James Wilson, in *Annual Report Queen Victoria Niagara Falls Park Commissioners*, 1897, pp. 11–15, with accompanying map showing proposed power sites. For suggested power sites on U. S. side see Adams, Alton, D., "Utilizing the Power of the Niagara Rapids" in *Engineering Magazine* (N.Y.), June, 1905, pp. 381–387.

Niagara falls. Any remaining power site there, or upon the Niagara river, or westward upon the Niagara escarpment, should never be permitted to be developed, except upon such terms and conditions as will absolutely and perpetually provide an alternative source for a cheap and sufficient supply of electrical energy for the municipalities of Ontario that are dependent for their electricity upon Niagara power. This provision should be made in view of a possible temporary disabling of the plant upon which the municipalities are now dependent, in view, of the future expiration of present contracts, and in view, also, of the increased light, heat and power demands of the future.

When the Ontario Power Commission was considering the selection of a site for a power plant at Niagara falls their experts pointed out four possible sites adjacent to the Falls. Three sites were situated above the head works of the Ontario Power Company; the fourth site, which involved a subterranean power house, was located just above the Horseshoe falls. The sites suggested were as follows: *

PLANT	HEAD	LENGTH OF TUNNEL (in feet)
1	150.91	6,220
2	156.30	5,450
3	164.35	4,300
4	155.00	400

The Hydro-Electric Power Commission, in its First Report, makes special reference to possible additional power sites. The Report recommends particularly a site above the intake of the Ontario Power Company, and states that

> "Such a plant would have a tunnel tail-race about 5,000 feet long and may be considered the cheapest and most suitable power site now available on the Canadian side of the Niagara river, the only others possible being either one between the Canadian Niagara Power Company's plant and that of the Electrical Development Company, and which would not be looked upon favorably, as its supply of water is shut out by the latter works; or else at a site between the Canadian Niagara Power Company's plant and that of the International Railway Company. This site is out of the question for two reasons: because of the extreme shallowness of the Niagara river adjacent, and because the gradual recession of the Falls would soon completely ruin even its present impracticable position, and there would be no remedy available, as the construction of a wing dam at this point would completely put out of business the plant of the International Railway Company.

* See *Official Report of the Ontario Power Commission*, Toronto, 1906; Report by Ross and Holgate, also Plate No. 1. Compare, also, *Report of Isham Randolph, C.E., upon the Further Development of the Niagara river for Power Purposes*, in *Annual Report of the Queen Victoria Niagara Falls Park Commissioners*, 1902, pp. 96-99: also *Ibid*, p. 14.

Should an additional electric power plant development be, for any reason required, it need not necessarily be constructed at Niagara Falls. In fact, there are strong reasons why a plant located about 18 miles west of Niagara Falls would be a more favorable one, as the water can there be used under 300 feet head, requiring thereby only about one-half the amount of water per H.P. which is used at Niagara Falls. The construction necessary would not disfigure the vicinity at Niagara Falls, and as the power would be generated at a point 18 miles nearer the Canadian market, this advantage would accrue to the consumer by lessening the cost of transmission. Sufficient studies and estimates have been made to show that a development can be made at this point at a cost per H..P not exceeding the cost of the Niagara developments."*

For other possible power sites at which it is proposed to utilize the waters of lake Erie conducted over the Niagara escarpment, consult the charters of the various power companies elsewhere referred to in this report.†

Northern Ontario Water-Powers

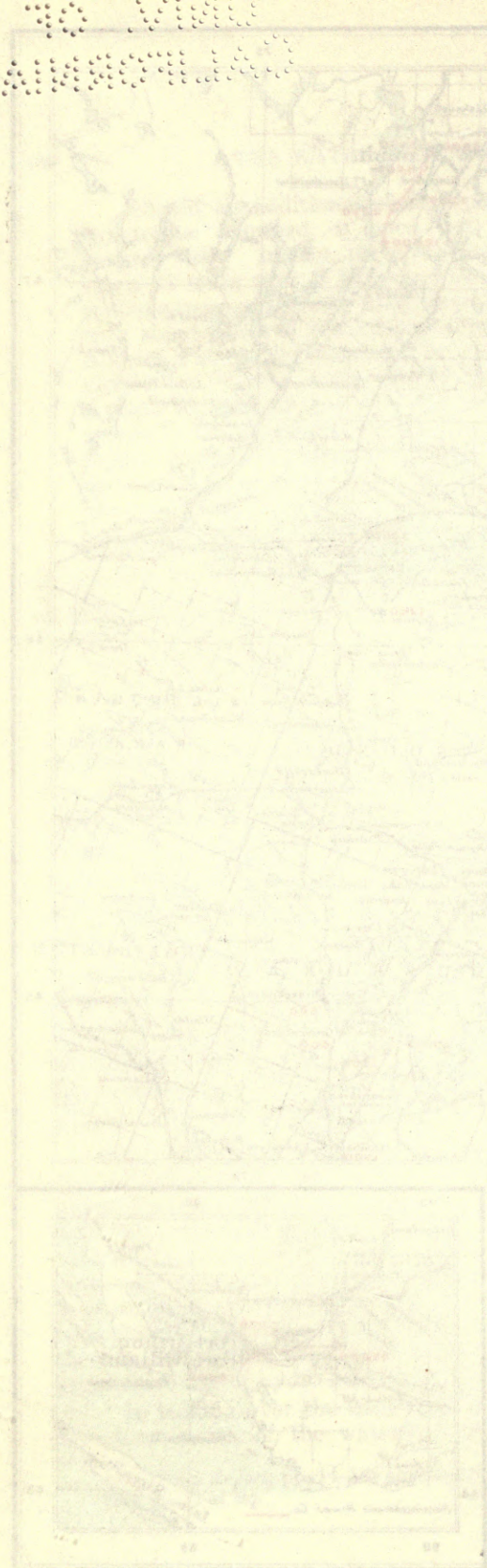
No special survey has yet been made to determine the possible water-powers that may be available upon the rivers of Northern Ontario which flow into Hudson and James bays. However, Mr. L. V. Rorke, Inspector of Surveys for the Ontario Government, has made a collection of data gleaned from published reports on these water-powers and has supplemented it by data obtained by himself in travelling over some of the rivers, as well as by data from various other sources. In an address delivered before the Association of Ontario Land Surveyors, and entitled *Water-Powers on our Northern Slope to James Bay, Province of Ontario,* Mr. Rorke gave the results of his research. His introductory remarks explain the character and limitations of the tabulated data and, bearing these in mind, the address may be taken as giving a representative idea of the locations and possible amounts of the water-powers in Ontario north of the height of-land. The address, in part, is as follows:

"In attempting to get together some information with reference to the water-powers on the rivers of Northern Ontario which empty into James bay and Hudson bay, a certain amount of latitude must be granted because of the lack of accurate information with respect to the different data which necessarily enter into an accurate computation of any water-power development. Having travelled over some of these rivers from their head-waters to their mouths, and taken some cursory notes, the writer feels that the impression gained and the information obtained respecting these water-powers, may be of interest to most of our members in this progressive age of hydro-electric development.

"In looking over the map of Northern Ontario, you will notice that the rivers north of the watershed draining into James bay assume a

* See *First Report,* pp. 14–15, also sketch map showing recommended site.
†See pp. 71 *et seq.*

TIMAGAMI FOREST RESERVE
Cobalt
Sudbury
GEORGIAN BAY
PARRY SOUND
MUSKOKA
HALIBURTON
ALGONQUIN PARK
Commission of Conservation
Canada
TRANSMISSION LINES
N.E. AND N.W. ONTARIO
Scale, 35 miles to 1 inch
Generating plants shown by solid circles
Transformer stations shown by hollow circles
Red figures indicate horse-power capacity
1,000
Transmission Lines
Nipissing Power Co.
Mines Power Co.
British Canadian Power Co.
Huronian Power Co.
Lorne Power Co.
Wanapitei Power Co.
Orillia, Midland, Bracebridge and Gravenhurst Municipal Plants
Kaministikwia Power Co.
Port Arthur
Fort William
Thunder Bay
Isle Royale



tentacular aspect with delicate feelers reaching out from the main body of water (Hudson bay) to the large bodies of fresh water which form the head-water lakes. Visit the ground and you find, during high-water period, that those great feeders have become raging torrents, with no sense of delicacy toward their surroundings. You may also notice the absence of lake expansions, so prevalent on the southern slope. If it were possible to show every little creek, stream and brooklet, it would be seen how systematically and completely nature has provided these small laterals supplying the larger watercourses. When your canoemen, in travelling up these rivers, hug the shores to keep out of the heavy current and to take advantage of the back eddies, you will notice numerous small natural drains occurring in quick succession, which you would pass unnoticed if travelling in mid-stream. This is particularly true of the 'Great Clay Belt.'

"The rivers in many respects are similar. In the lower reaches they become wide, shallow and swift, after tumbling down over what has been termed by geologists, the Archæan boundary, where an altitude of approximately 250 feet is overcome in a distance of from 5 to 15 miles, by a series of falls and rapids. The principal falls on each river at this Archæan boundary are as follows: On the Missinaibi, at the end of Long portage, at what is known as 'Hell Gate,' a fall and rapid of 140 feet; on the Opazatika, at Break-neck falls, a descent of 60 feet; on the Mattagami, at the Long portage, falls and rapids of 150 feet; on the Abitibi, the Long rapids between the mouth of Little Abitibi river and New Post, 160 feet and a fall of 110 feet at Kawash falls on the Nettogami, a tributary of the French river. Above this Archæan boundary the current in the rivers is not so strong, and the streams are broken by a succession of falls and rapids with intervening stretches in which the velocity of the current varies from one-third of a mile to two miles an hour.

"The large lakes at or near the head-waters are fairly uniform in altitude, being approximately 1,000 feet above sea-level. They may be enumerated as follows: Abitibi lake on the Abitibi river; Frederickhouse and Nighthawk lakes on the Frederickhouse river; the Mattagami and Kenogamissi lakes on the Mattagami river; Pishkanogama, Matagaming and Rice lakes on the Kakozhisk river; the Missinaibi, Kapuskasing, Opazatika, Kabinakagami, Kenogami and Ogoki lakes at or near the heads of the respective rivers of the same name; Rainy lake, lake of the Woods, lac Seul and lake Joseph on the upper waters of the Winnipeg, English and Albany rivers. The drainage basin—within the limits of the Province of Ontario—of these several rivers, is approximately 100,000 square miles.*

"The drainage area and head-waters of the Ottawa river adjoin the drainage areas and head-waters of some of those herein enumerated. The Ottawa has been carefully gauged and investigated in connection with the Georgian Bay canal scheme, with the result that the average annual precipitation for the ten years preceding 1906 was found to be 31.72 inches, and the average discharge was 53 per cent of the precipitation, or 16.8 inches. The drainage area is 56,000 square miles, and,

*At this point in his address, Mr. Rorke referred to the requirements which data must meet when used as a basis for accurate estimates of possible water-power. As these requirements have already been referred to, in the foregoing pages, under sections entitled "Necessity for Reliable Data" and "Reconnaissance Surveys," they are here omitted.

UNIV. OF CALIFORNIA

for the same ten years, the average yearly mean discharge was 56,641 cubic feet per second. The maximum high-water discharge was three times the mean discharge, and the minimum low-water discharge 65–100 of the mean discharge. The results obtained from this discharge area are, that the mean discharge is one cubic feet per second per square mile of area, and the minimum low-water discharge is .65 cubic feet per second per square mile of area.

"Table No. IX on page 136 shows the area of the drainage basin, the total discharge and the discharge per square mile of area, of a number of rivers of Northern Ontario.

"The average minimum discharge of these rivers is .46 c.f.s. per square mile, and for the purpose of this paper it will be well within the limits to assume a discharge of .4 c.f.s. per square mile.

"On the western part of the slope, the total precipitation is less than in the Ottawa River basin, but the percentage of run-off is greater. The average yearly precipitation during ten years in the Winnipeg River basin has been 23 inches, and the run-off 70 per cent. of the precipitation, or 16.1 inches, practically the same as in the Ottawa River basin.

"In these rivers of the Northern Slope, the high-water run-off is more gradual than on the southern. In such rivers as the Nipigon, Magpie, Pigeon, Spanish, French and others draining the north shores of lakes Superior and Huron, the spring freshets are heavier and of shorter duration, because of the large amount of rock-exposed territory and the more broken and steep hills therein. The maximum discharge is not reached on the northern slope until late in the month of May or early in June and, owing to the gentler slopes of the land and the forest-covered area, the run-off is more gradual. Taking this into consideration, the annual discharge can be more easily and uniformly controlled and requires less storage than such rivers as are mentioned above.

"On the Abitibi river, for example, we have a storage basin of 460 square miles in the Abitibi, Nighthawk and Frederickhouse lakes. With a rise of 10 feet above low-water mark (one square mile one foot deep =.88 c.f.s.), a storage of 4,000 c.f.s. could be secured to maintain a mean discharge during the low-water months. This is quite sufficient after allowing a reasonable percentage for evaporation.

"A cross section of the Abitibi river, near where it crosses the National Transcontinental railway, gives an area of 5,000 square feet below normal water level and 10,000 square feet in mean high water. The water from an area of 6,500 square miles discharges through this sectional area, in low water at the rate of one-third of a mile per hour, in high water at the rate of one and a quarter miles per hour. This calculation is based on the principle that the low flow is .4 c.f.s. per square mile, and the mean high water, .53 c.f.s. per square mile.

"From this cross sectional point, which is 800 feet above sea level,—after deducting 280 feet in the falls and rapids, which are noted, and 200 feet for the lower reach of the river, where a uniform fall of probably two feet per mile exists,—there remains a fall of 320 feet in a distance of 200 miles, or about 1.6 feet to the mile. This, of course, includes many minor rapids, which, when estimated, would reduce the uniform river velocity to probably what is deduced from the above sectional discharge.

"It has been ascertained that on the Winnipeg river, in the province of Manitoba, an aggregate head of 247 feet is available for horse-power development, with a minimum efficiency of 486,000 H.P., which is equal to one-fourth that of the great Horseshoe fall at Niagara. It may be of provincial interest to state that seventy-five per cent. of the drainage basin of the Winnipeg river lies within the province of Ontario, and 95 per cent. of the total discharge passes through the Province before reaching the outlet into lake Winnipeg. With control dams at lake of the Woods, Rainy, Seul and other large lakes on this river and its tributary, the English river, the minimum efficiency of all powers on this river, both within and without the Province, could be doubled.

"The large water-powers in Ontario on this river are enumerated herein, giving the same minimum low-water flow per mile as those in the more eastern portion of the slope. The White Dog fall about 15 miles below the point where the National Transcontinental railway crosses the river, is the third largest water-power in the Province, Niagara being the first and Sault Ste. Marie the second.

"In compiling this aggregate estimate, the error is a minus quantity. Many rapids on these large rivers are not noted, and many falls on the smaller tributaries, such as the French, Little Abitibi, Muskego and Wabigoon rivers, which will develop from 500 to 5,000 horse-power, do not figure in this total. The margin will be quite sufficient to balance the loss in converting from theoretical to practical horse-power, the loss in transmission of energy to points within reasonable distance, and all other losses which occur between the water-power in its natural state and the article manufactured by means of that power.

"As to the ultimate development and disposal of this great amount of water-power, it is not within the limits of this brief paper to conjecture. Suffice it to say that the power is all within a distance of 100 miles from railway facilities, and thus can be transmitted without too great a loss even at this date, to meet the raw material at shipping points; and in years to come, when these water-powers have been harnessed and put under man's control, the writer believes the results will fully substantiate these figures.

"The following tabulated list of water-powers is calculated on the drainage area basis as described.* The natural head in feet as given in the second column, is obtained from reports by surveyors, geologists, explorers and others, and, although not always accurate in measurement, is reliable. The drainage area as given in the third column is fairly well defined on the maps of Northern Ontario. The estimated minimum flow as given in the fourth column means the minimum amount that can be counted on every day in the year without increasing the natural head and without storage. The minimum amount of horse-power that this will develop is given in the sixth column. The volume of water under controlled storage sufficient to maintain the mean discharge of 1 c.f.s. per square mile area is given in the fifth column, and the amount of horse-power that this will develop is given in the seventh column."

It will be observed that the grand total of 2,030,600 H.P. is based upon *controlled* discharge. If the minimum 24-horse-power, under

*See Table No. IX. on page 136.

natural flowage, is the basis of consideration, as is the case in the Hydro-Electric Power Commission Reports, then Mr. Rorke's total will be only about 800,000 H.P.

Explanation of Statistical Tables

In the tables which follow, the principal statistical data regarding the water-powers of Canada are given. The power sites are arranged consecutively under the different rivers upon which they are situated, and in the majority of cases the tributaries are listed under the rivers into which they flow. An index number precedes the name of each power or group of powers, and corresponding numbers will be found upon the accompanying maps, thus constituting a ready means of reference, either from the maps to the listed powers, or *vice versa*.

In the column "Head (in feet)" is given the minimum head available under natural conditions; or, if the power has been developed, the head that is actually being used. Unless so specified, the heads given are not necessarily any indication of the heads it may be possible to secure by the construction of special conservation works.

The column "H.P." gives the estimated horse-power for conditions of minimum flow. Generally speaking, this has been arrived at in the manner described on pages 19 to 21. It should be noted, however, that, in the case of smaller rivers, there are usually some months in the year when no power whatever is available.

The column "Electrical Energy used, 1910" shows, in electrical horse-power, the maximum load carried by the plant. In most instances, the plant is called upon to deliver this load for only a few hours each day. This column is subdivided so as to indicate the amounts used for light and for power.

In the column, "Developed (Horse-Power)" are given the amounts of power respectively used for various industries; also the total horse-power developed.

Information from the various reports from which these data were taken has been supplemented by data obtained from published descriptions of power developments, and by correspondence with persons having knowledge of power conditions in various localities.

The greater portion of the data tabulated for Ontario has been taken from the only source from which it is to be had, viz., the Reports of the Hydro-Electric Power Commission.

The data respecting the powers on the Ottawa, Mattawa and French rivers has been taken from the Report of the Georgian Bay Ship Canal Survey, while that respecting the Trent and other canals was obtained

COUCHICHING FALL, ABITIBI RIVER, ONT.

Courtesy Hydro-Electric Power Commission

GAJIGAMOK FALL, ENGLISH RIVER, ONT

from the Department of Railways and Canals. Information has also been secured from the Survey and Exploration Report of Northern Ontario in 1900, from the Reports of the Ontario Bureau of Mines, and also from the companies operating at Niagara falls and elsewhere throughout the Province.

In the Hydro-Electric Power Commission Reports the water-power data have been estimated upon the basis of 24-hour power, and an assumed efficiency for hydraulic machinery of eighty per cent. Hence the quantities given in these reports, as quoted in the following tables, would have to be increased twenty-five per cent to bring them to a theoretical basis.

The horse-power given in the tables for the Ottawa river, and for the Lower Trent river, are estimated theoretical quantities.

The amount of power given for the smaller power sites, especially those located upon the rivers having great variations in their flow, must, generally speaking, be regarded as representing the horse-power available for only those portions of the year that are not unduly affected by conditions of draught. Further, the quantities for these smaller sites frequently represent ten- or twelve-, and not twenty-four-hour power.*

*Sources of information relating to the waters and water-powers of Ontario may be found at greater length in the list of reports tabulated in the *Bibliography*.

ONTARIO

DISTRICT No. I.—ST. LAWRENCE RIVER AND TRIBUTARIES

Power Site	Minimum		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				REMARKS
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
St. Lawrence canals:									
1. Cardinal	6						200	200	Edwardsburg Starch Works
2. Iroquois	14						40	40	M. F. Beach
"			20	70	90			90	Town of Iroquois pumping and electric plants
3. Morrisburg	11	1,410							Gibson lease, 60 H.P.
"			50	300	250			250	Town of Morrisburg pumping and electric plants
"					1100			1,100	New municipal lease for electric power
4. Cornwall									
Mille Roches	20		1,000	300	2,700			2,700	St. Lawrence Power Co.; normal head, 28 ft.
Lock 20	8	1,000							
" 19	6	760							
" 18	7.5	950				800		800	Toronto Paper Mfg. Co.
							50	50	Municipal pumping plant
" 17	20	2,540					1,500	1,500	
							1,200	1,200	Canada Coloured Cotton Co.
							200	200	
					80		50	130	Cornwall Elect. Lt. & Street Ry. Co., and Wm. Hodge flour mill

St. Lawrence river:[a]									
5. Galops, Cardinal and Iroquois rapids.	15	232,000							
6. Rapide Plat	11	178,000							
7. Long Sault	40	618,000	38,000	2000	40,000			40,000	St. Lawrence River Power Co., Massena, N.Y. (Extensions are being made)
Gananoque river:	21	365					50	50	Cowan & Britton
							50	50	O. D. Cowan
							100	100	Skinner Co.
8. Gananoque	17						250	250	Spring & Axle Co; use steam auxiliary
"	14				250			250	Electric light plant
"							65	65	Rolling mill
"							80	80	Ontario Wheel Works
"							75	75	Parmeter & Bullock; use steam auxiliary
"							90	90	Toronto Bolt & Forge Co.
"							40	40	St. Lawrence Steel & Wire Co.
"	7						40	40	McClellan & Shememan, flour mill
"	7						95	95	Grist mill
							20	20	Mitchell & Wilson
							150	150	G. F. Jones, tool factory
							10	10	W. G. Gibson
Small creek at Lyn:									
9.							100	100	Flour mill
Garry river:									
10. Alexandria	18						100	100	Grist mill

[a] The estimated quantities of horse-power for the St. Lawrence river given in the Table are from the *Report of the Hydro-Electric Power Commission*. The estimated low-water flow as used by that Commission is 170,000 cubic feet per second. According to the latest investigations, the average discharge for the St. Lawrence river at its head, for the period 1860 to 1907 is 254,400 cubic feet per second. The greatest excess average for any one month was 96,800 c.f.s., or 38 per cent. and occurred in May, 1862; the greatest excess average for any one year was for 1862, being 49,000 c.f.s., or 19 per cent.; the greatest deficiency average for any one month was 102,200 c.f.s., or 40 per cent. and occurred in February, 1902; and the greatest deficiency average for any one year was for 1895, being 62,800 c.f.s., or 25 per cent. See *Report of International Waterways Commission on the Regulation of Lake Erie*, Ottawa, 1910, page 10.

ONTARIO

DISTRICT No. II.—TRIBUTARIES OF LAKE ONTARIO
(including Trent Valley powers)

Power Site	Minimum		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				REMARKS
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
Napanee river:[a]									
11. Napanee	30						500	500	Grist mill, lumber mill and furniture factory
12. Strathcona						75		75	
13. Newburgh							150	150	Foundry and grist mills
14. Camden East						75		75	
15. Yarker,	32						125	125	Carriage wheel factory
Small stream at Bloomfield:									
16.	12						30	30	Grist and lumber mill
Moira river:									
17. Belleville, first dam		300					110	110	
" second dam	6						110	110	
" undeveloped	15	550							
" third dam	9.4	340					65	65	
" fourth dam	8.6	320					50	50	
" fifth dam	8	300							
" Chisholm mills	10	370							
" Lost channel		33							
18. Tweed, old electric light plant	10	230							
" Deseronto Milling Co.	10	230					100	100	
" Electric Light Co	9	200		70	100			100	
" undeveloped power	6	140							

[a] There are several lakes on this river above Bellrock controlled by the Napanee River Improvement Co.

19.	Glen Lewis	8	6							
20.	Actinolite	30	350							Partially developed
21.	High fall	35	410							Undeveloped
22.	Long slides	50	550							"
Lower Trent river:[b]										
23.	Dam 1, Trenton Junction	17.5	3,977	450	450	900			900	Trenton Electric and Water Co.
24.	" 2	20.0	4,545							
25.	" 3, Glen Miller	27.0	6,137				1,000		1,000	Miller Bros., Ltd.; use only 9 ft. of an available 27 ft. head. Could only be developed with Miller Bros.' consent.
26.	" 4	18.0	4,090							
27.	" 5	18.0	4,090							
28.	" 6, Frankford	16.0	3,636		40	40	960		1,000	Trent River Paper Co.
29.	" 7, Glen Ross	5.0	1,136							
30.	" 8, foot of Myers island	30.0	6,817							
31.	" 9, head of Myers island	24.0	5,454							
32.	" 10, Ranney fall	48.0	10,908					500	500	
33.	" 11, Stephens rapid at Campbellford	23.	5,227	1,500	800	4,000			4,000	Seymour Power & Electric Co.,[a] supplying current to Campbellford, Deloro Madoc and Belleville (through Trenton Electric & Water Co.) and Sulphide, Stirling and Pt. Anne.
34.	" 12, Middle fall	25.	5,681	200	330	530			530	Campbellford municipal electric plant.
35.	" 13, Healey fall	66.	11,250							76 ft. head could be obtained at considerable expense.
36.	" 14, Hastings	9.	1,534		100	100		375	475	Lumber and grist mills and electric plant
Cold Creek:										
37.	Frankfort	10.						125	125	Grist mill
Crow river:										
38.	Marmora	15.			78	78		350	428	Lumber mill and electric plant
Beaver creek:										
39.	St. Ola	12.						200	200	Lumber mill

a Controlled by The Electric Power Co.

For data respecting discharge, levels, etc., on the Lower Trent river, consult *Annual Report of the Department of Railways and Canals;* Sessional Papers, Canada, No. 20, 1911; pp. 3-284 *et seq.*

DISTRICT No. II.—TRIBUTARIES OF LAKE ONTARIO—*Continued*
(including Trent Valley powers)

Power Site	Minimum		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				REMARKS
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
North river:									
40. Burnt dams. (6 m. from Havelock)	21	.....	.....	130	300	.....	.....	300	Havelock Electric & Power Co.
Ouse river:									
41. Norwood	16	.....	.....	.....	.....	.....	65	65	Grist mill
Upper Trent river:									
42. Peterborough Hydraulic Power Co.	27	3,200	2,000	1,000	3,500	.....	.....	3,500	
Auburn mills	12	1,100	.....	.....	.....	.....	680		Auburn Woollen Co. Water rights acquired by Peterboro Light & Power Co., who are installing electric generators of 2,000 H.P. capacity.
Water works	10	900	.....	.....	.....	.....	70	.....	
Canadian General Electric Co.	15	1,365	1,200	200	1,400	.....	.....	1,400	
No. 5 dam, Otonabee Power Co.	14	1,280	.....	.....	.....	.....	1,700	1,700	
No. 4 " " " "	12	1,100	.....	.....	.....	.....	.....	.....	Undeveloped
No. 3 " " " "	12	1,100	750	40	1,350	.....	.....	1,350	Electric energy for Canada Cement Co.
No. 2 " " " "	10	900	.....	.....	.....	.....	.....	.....	Undeveloped
No. 1 " " " "	12	1,100	.....	.....	.....	.....	800	800	Lumber and grist mills
43. Youngs point	7	600	250	.....	535	.....	.....	535	Electric energy for Canada Cement Co.
44. Burleigh fall	25	1,800	.....	.....	.....	.....	.....	.....	Undeveloped
45. Buckhorn rapid	12	870	.....	.....	.....	.....	.....	.....	"
46. Bobcaygeon	6	300	.....	200	200	.....	100	300	Municipal electric light plant and grist mills

47. Fenelon falls	24	720	375	450	1,600		.....	1,600	Light, Heat & Power Co. of Lindsay
48. Elliott falls	21.5	930	.....	.....	.....	.....	930	930	
Pigeon river:									
49. Omemee	6	.....	.....	.....	.....	.....	40	40	Machine shop
Scugog river:									
50. Lindsay	8	.....	.....	.....	.....	.....	250	250	Grist mill
Burnt river:									
51. Kinmount	60	.....	.....	.....	.....	.....	150	150	Lumber mill
Baxter creek:									
52. Millbrook	15	.....	.....	.....	.....	.....	60	60	Grist mill
Cobourg brook:									
53. Baltimore	42	.....	.....	.....	.....	.....	65	65	Grist mill
Ganaraska river:									
54. Port Hope	25	.....	30	200	300	.....	.....	300	Port Hope Electric Light & Power Co; has steam auxiliary
54. " "	13	.....	.....	.....	.....	.....	100	100	Lumber and grist mills
55. Seven miles above Port Hope	50	.....	.....	.....	.....	.....	.....	.....	Being developed
Soper creek:									
56. Bowmanville	20	.....	.....	.....	.....	.....	50	50	Grist mills
Barber creek:									
57. Bowmanville	28	.....	.....	50	50	.....	50	100	Grist mill and electric plant
Oshawa creek:									
58. Oshawa	21	.....	.....	.....	.....	.....	150	150	Tannery
"	16	.....	.....	130	180	.....	.....	180	Have steam auxiliary
"	26	.....	.....	.....	.....	.....	70	70	Grist mill
Duffin brook:									
59. Greenwood	42	.....	.....	.....	.....	.....	66	66	Grist mill
Rouge river:									
60. Markham	13	.....	.....	.....	.....	.....	70	70	Grist mill

DISTRICT NO. II.—TRIBUTARIES OF LAKE ONTARIO—*Continued*
(including Trent Valley powers)

Power Site	Minimum		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				REMARKS
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
Humber river:									
61. Weston	12						50	50	Grist mill
62. Bolton	14						60	60	Grist mill
Credit river:									
63. Streetsville	10		45	45	90			90	Municipal electric plant
63. "	12						165	165	Grist mill
64. Georgetown, Lawson's							55	55	" "
64. "	12			100	100			100	Use steam auxiliary
64. " Sykes & Ainlay	14						77	77	
64. " " "	11						80	80	
64. " Barber & Sons	23		75		75			75	Electric energy for paper mill
64. " " "	13					75		75	Paper and pulp mill
64. " Jos. Beaumont	12						50	50	
65. Norval, R. Noble	16						300	300	Flour mill
Oakville creek:									
66. Oakville	32						70	70	Grist mill
67. Milton	22						60	60	" "
Dundas creek:									
68. Dundas	22						75	75	Grist mill

ONTARIO

DISTRICT NO. III.—NIAGARA

(For Detailed Description of Power Conditions at Niagara falls and upon the lower Niagara river see the sections above, which treat specially of these subjects.)

	Power Site	Available		Electrical Energy Used 1910 (Horse-power)	Developed (Horse-power)				REMARKS
		Head (in feet)	H.P.	Light and Power	Electrical Energy	Paper and Pulp	Other Industries	Total	
69.	Canadian Niagara Power Co.	141	110,000	46,613	62,500	.....	.....	62,500	Six generators installed
	Ontario Power Co. of Niagara falls	176–180	200,000	54,765	102,000	.....	.....	102,000	Nine generators installed and a tenth in process of installation, making, in all, 114,000 H.P.
	Electrical Development Co. of Ontario (Toronto Power Co., Ltd.)	130–145	125,000	22,157	56,200	.....	.....	56,200	Five generators installed
	International Railway Co.	60–68	10,000	.....	.....	.....	.....	.....	This company sent no reply to enquiries.
	Municipality of Niagara Falls, Ont.	25	500	.....	.....	.....	.....	500	Power used for civic pumping purposes.
	Rapids of lower Niagara river	94·5	215,000	.....	.....	.....	.....	.....	Estimated theoretical H.P. based upon diversion for Canada of 20,000 cubic feet per second as recommended by the International Waterways Commission
Welland canal:									
70.	Port Dalhousie	12	.....	.....	.....	.....	500	500	Rubber mfg.
	St. Catharines	9.5	.....	.....	.....	.....	325	325	Welland Vale Mfg. Co.
	" "	11	.....	.....	150	.....	.....	150	Lincoln Electric Light and Power Co.
	" "	12	.....	.....	.....	.....	320	320	Whitman & Barnes
	" "	12	.....	2,000	2,000	.....	.....	2,000	Carbide works
71.	" "	21	.....	.....	.....	600	.....	600	
	" "	19	.....	.....	.....	.....	260	260	Milling Co.
	" "	13	.....	.....	.....	.....	50	50	Hair cloth mfg.
	" "	19	.....	.....	.....	.....	100	100	Black & Son
	" "	19	.....	.....	.....	.....	150	150	Electric Mfg. Co.

DISTRICT NO. III.—NIAGARA—*Continued*

(For Detailed Description of Power Conditions at Niagara falls and upon the lower Niagara river see the sections above, which treat specially upon these subjects)

	Power Site	Available		Electrical Energy Used 1910 (Horse-power)	Developed (Horse-power)				REMARKS
		Head (in feet)	H.P.	Light and Power	Electrical Energy	Paper and Pulp	Other Industries	Total	
72.	Merritton	12					100	100	Wheel works
	"	15				200		200	
	"	11					25	25	James Wilson
	"	12				1,350		1,350	
	"	14					190	190	McLeary & McLean
	Thorold	14					150	150	Penman Mfg. Co.
	"	14				300		300	
	"	12				340		340	
	"	12					30	30	Monroe & Roantree
	"	12					150	150	Town of Thorold
	"	12					300	300	Milling Co.
	"	23					625	625	James Davy
	"	23					400	400	Foley-Reiger Co.
	"	11					10	10	Est. J. Battle
73.	Point Robinson	10					25	25	Hyslop Bros.
74.	Welland	8					100	100	Milling Co.
	"	16					60	60	Town of Welland
75.	Marshville	10					25	25	D. Piggott
76.	Cataract Co., De Cew fall	260			50,000			50,000	Hamilton Cataract P. L. & T. Co.; estimated volume used 1800 c. f. s.

DISTRICT No. IV.—TRIBUTARIES OF LAKE ST. CLAIR AND LAKE ERIE

	Power Site	Minimum		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				REMARKS
		Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
Grand river:										
77.	Dunnville	7			100	100		400	500	Grist and woollen mills
78.	York	4.5						55	55	Grist mill
79.	Caledonia	7						270	270	Caledonia Mill Co.
80.	Brantford	16		550	550	1,100		275	1,375	
81.	Paris	8						370	370	Grist and woollen mills
82.	Galt	9				200		60	260	
83.	Elora, lower dam	40	20					35	35	
	" " "	42								
	" " "	16						60	60	
	" upper dam	12	25					65	65	
84.	Fergus	16						125	125	Linseed oil mill
	"	15						125	125	Oatmeal mill; has steam auxiliary
	"	22								
Whiteman creek:										
80.	Brantford	13						80	80	Grist mill
Nith river:										
81.	Paris	13	170	15	118	133		250	383	Woollen mills and electric plant
85.	Wolverton	8						100	100	Grist mill
86.	Ayr	10						200	200	" " etc.
87.	New Hamburg	9						80	80	" "
88.	Wellesley	7						100	100	" "

DISTRICT No. IV.—TRIBUTARIES OF LAKE ST. CLAIR AND LAKE ERIE—*Continued*

Power Site	Minimum		Electrical Energy Used, 1910 (Horse-power)			Developed (Horse-power)			REMARKS
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
Speed river:									
89. Preston	7						150	150	Grist mill and woollen mills
90. Hespeler (1½ miles distant)	8	50					60	60	Woollen mill
90. "	14	90					200	200	" "
90. "	9						100	100	Woollen mill; uses steam auxiliary
91. Guelph	11				100			100	Municipal electric plant
91. "	18						200	200	Grist mill; uses steam auxiliary
Small creek:									
92. Waterloo	16						75	75	Grist mill; uses steam auxiliary
Conestoga river:									
93. Conestoga	14						65	65	Grist mill
Nanticoke creek:									
94. Waterford	18						60	60	Grist mill
Lynn river:									
95. Port Dover	13						150	150	Grist and woollen mills
96. Lynn Valley	10						100	100	Grist mill
96. " " (Brooke dam)	13						125	125	
97. Simcoe	10						60	60	Grist and woollen mill
97. " (Sutton)	13						125	125	Grist mill
97. "	14						100	100	Shoddy mill

Spring creek:										
98.	Port Rowan	16						40	40	Grist mill
	" "	12						30	30	Lumber mill
99.	St. Williams	9						25	25	Lumber mill; uses steam auxiliary
Big creek:										
100.	Delhi	15	46					100	100	Lumber and grist mill
	"	26	85	75	100	200			200	
101.	Teeterville	8						50	50	Grist mill
Otter creek:										
102.	Vienna	8						50	50	Grist mill
103.	Tillsonburg	18	60					200	200	Grist mill; uses steam auxiliary
Clear creek:										
103.	Tillsonburg	16						50	50	
104.	Ponds near Port Stanley	22						35	35	Grist mill
		17						35	35	" "
Thames river:										
105.	Delaware									Possible development
106.	Byron mills	5								Undeveloped
107.	Springbank	12	135					150	150	London water works
Thames river, South branch:										
107.	Meadow-lily dam	8								Undeveloped
	London, Hunt dam	9	60					90	90	Flour mill
108.	Dorchester	15								Undeveloped
109.	Ingersoll	7						20	20	Woollen mill
110.	Beachville	9						30	30	Cereals
111.	Tributary at Embro	13						40	40	Grist mill
Thames river, North branch:										
London										
107.	Saunby dam	9						150	150	Grist mill
	Dexter dam	8						40	40	" "
	Byron dam	9						50	50	" "
	Broughdale	9						50	50	" "

All have steam auxiliaries

DISTRICT No. IV.—TRIBUTARIES OF LAKE ST. CLAIR AND LAKE ERIE—*Continued*

Power Site	Minimum		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				REMARKS
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
St. Mary's									
Carter dam	10	.....	.....	.....	.....	.....	150	150	Grist mill } All have steam
	6	.....	.....	.....	.....	.....	50	50	" " } auxiliaries
112. Mathewson dam	8	.....	.....	.....	.....	.....	125	125	" "
Thames Cereal Co.	10	.....	.....	.....	.....	.....	.....	.....	Undeveloped
Nichols dam	8	.....	.....	.....	.....	.....	.....	.....	"
113. Mitchell	12	.....	.....	.....	.....	.....	80	80	Grist mill; uses steam auxiliary
Midway river:									
114. Arva	15	.....	.....	.....	.....	.....	60	60	Grist mill; uses steam auxiliary
Trout creek:									
115. Harrington dam	18	.....	.....	.....	.....	.....	70	70	Grist mill
Black creek:									
116. Knott dam	18	.....	.....	.....	.....	.....	50	50	" "

ONTARIO

DISTRICT No. V.—TRIBUTARIES OF LAKE HURON

Power Site	Minimum		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				Remarks
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
Ausable river:									
124. Near Arkona	12	.....	73	35	108	.....	.....	108	Electric plant; Rock Glen Power Co.
125. Exeter	9	.....	.....	.....	.....	.....	50	50	Municipal water works
Warren creek river; (*tributary of Ausable*)									
126. 1½ m. from Hensall	16	.....	.....	.....	.....	.....	40	40	Lumber mill
Tributary of Bayfield river:									
127. Kippen (2½ m. north of Hensall)	14	40	.....	.....	.....	.....	40	40	Grist mill
Maitland river:									
128. Goderich	30	380	.....	.....	.....	.....	.....	.....	Undeveloped; storage for 24 hours
129. Black Hole	80	1,020	.....	.....	.....	.....	.....	.....	Undeveloped
Maitland river, North branch:									
130. Wingham, lower dam	16	53	8	107	360	.....	.....	360	Electric light plant; steam auxiliary for 5 months
130. Wingham, upper dam	10	35	.....	.....	.....	.....	180	180	Flour mill and pump house; steam for 5 months
131. Wroxeter	10	100	.....	.....	.....	.....	100	100	Grist mill
Lucknow river:									
132. Lucknow	10	.....	.....	.....	.....	.....	125	125	Lumber and grist mills

DISTRICT No. V.—TRIBUTARIES OF LAKE HURON—*Continued*

Power Site	Minimum		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				REMARKS
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
Saugeen river:									
133. Southampton, at Denny dam	13	430	40	160	300	.....	.....	300	Saugeen Light & Power Co's development
133. " possible development..	40	1,310	.....	.....	.....	.....	.....	.....	Dam to drown out Denny dam; good storage for 24 hours
134. Rapid above Paisley	8	180	.....	.....	.....	.....	.....	.....	
135. Rapid 2½ miles below Walkerton.....	10								
	10	225	.....	.....	.....	.....	.....	.....	
136. Walkerton at Truax dam....	12	300	.....	90	90	.....	420	510	Lumber mill, 200 H.P.; roller mill, 100 H.P.; rope factory, 120 H.P.
136. Rapid above Walkerton	10	225	.....	.....	.....	.....	.....	.....	
137. Maple Hill.....	9	200	40	150	200	.....	.....	200	Hanover electric light plant; entirely developed.
138. Hanover.....	18	400	.....	.....	.....	.....	500	.....	Hanover Portland Cement Co.; use steam auxiliary.
Saugeen river, North branch:									
139. McIntyre dam, near Paisley...	12	15	.....	135	135	.....	.....	135	Paisley electric light plant
140. Chesley.....	10	12	.....	.....	.....	.....	250	250	Crook Bros., furniture. Electric light plant. Limited daily use.
Teeswater river:									
139. Paisley.....	10	250	.....	.....	.....	.....	250	250	Grist and lumber mills
141. Teeswater.....	13	65	.....	.....	.....	.....	65	65	Grist mill
"	105	.....	.....	.....	.....	.....	50	50	" "
142. Tributary at Pinkerton.....	18	.....	.....	.....	.....	.....	80	80	" "

Otter creek: (*tributary of Saugeen*)									
136. Walkerton	23						50	50	Grist mill
143. Mildmay	20						100	100	Lumber and grist mill
Rocky Saugeen river:									
144. Aberdeen	17	108		100	100			100	Durham electric light plant
145. Glen Roden	17	108							Lumber mill
146. Hayworth fall	31	195							Markdale electric light plant
146. Hayworth fall, possible	60	380							Possible maximum development
147. Traverston	18	110							Flour mill
147. Traverston, possible	50	310							Possible maximum development
Muddy Saugeen river:									
148. Dalgleish rapids	40	180							
149. Durham, at McKechnie dam.	13	60					80	80	Flour mill
149. Durham, at McKechnie dam.	12	55							Undeveloped below mill
149. Durham, at McGowan dam.	20	90					60	60	Flour mill
150. Purdy mill	15	40							
151. Priceville	10	18							
Sable river:									
152. Sable fall	18	90		200	200		50	250	Electric light plant for Wiarton and saw mill

DISTRICT No. VI.—TRIBUTARIES OF GEORGIAN BAY NORTHWARD TO MUSKOKA RIVER

Power Site	Minimum		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				Remarks
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
Gleason brook:									
153. Oxenden	22						70	70	Lumber mill
Sydenham river:									
Owen Sound									
154. Woollen mill	15	15					140	140	
154. Electric light	33	75	20	40	60			60	Have steam auxiliary
154. Saw mill	14	32							
154. Inglis mill	37	84					90	90	Grist mill
Pottawattomi brook:									
154. Owen Sound	20						50	50	Grist mill
154. " "	25						45	45	Lumber mill
155. Derby	14						50	50	Grist mill
Beaver river:									
156. Thornbury	15	[a]		100	100		100	200	Grist and cereals
157. Eugenia fall	420	1,090			46			46	Proposed development of Georgian Bay Power Co.: Flesherton electric light plant, 46 H.P.; utilizes 17 feet of this head
Silver creek:									
158. Mair mills	24						25	25	Grist mill

[a] Stated that 2,000 H.P. can be generated by raising the dam—very doubtful.

Pretty river:									
159. Collingwood	18						70	70	Lumber and grist mill
Coldwater river:									
160. Coldwater	8						50	50	Grist mill
Nottawasaga river:									
161. The Fishery (near Ivy)	10	72					35	35	Lumber mill
Tottenham brook:									
162. Tottenham	16						25	25	Grist mill
Boyne river:									
163. Alliston	18	52		150	150		150	300	Grist mills and electric plant. Electric plant has steam auxiliary
Pine river:									
164. Hornings mills	60	54							Grist mill
164. " "	75	68							42 ft. head is developed.
165. Kilgorie	125	250							Two miles below Hornings Mills; proposed development by Dufferin Light & Power Co., to transmit energy to Orangeville, Shelburne, etc.
Mad river:									
166. Creemore	20	54		75	75		75	150	Grist mill and electric lighting plant
167. Glencairn	25	72							
168. Glen Huron	27						150	150	Lumber and grist mills
169. Singhampton	22						115	115	" " "
170. Lavender fall (on Noisy river)	64	90							Undeveloped
Beaverton river:									
171. Beaverton	12						100	100	Grist mill
Tributary of Pefferlaw brook:									
172. Uxbridge	10			23	23		140	163	Grist mills
Holland River:									
173. Newmarket	21						65	65	Furniture

DISTRICT No. VI.—TRIBUTARIES OF GEORGIAN BAY NORTHWARD TO MUSKOKA RIVER—*Continued*

Power Site	Minimum		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				REMARKS
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
Severn river:									
174. Port Severn	11	750							
175. Little chute	10	650							
176. Big chute	58	3,350			3,000			3,000	Simcoe Ry. & Power Co.; electrical energy transmitted to Midland and Penetanguishene.
177. Ragged rapids	35	2,020			1,600			1,600	Orillia electric light and power plant
Moon river:									
178. High fall / Twin falls	60	3,300							
179. Curtain chute	6	330							
179. Seven Sisters rapid	20	1,100							
179. Knife rapid	9	510							
179. Annie Rooney rapid	8	460							
179. Island portage	15	860							
Bogart creek: (*trib. to Threemile lake*)									
180. Ufford	26	60					60	60	Lumber mill
Muskoka river:									
181. First and second falls	20	430							
181. Third fall	12	260							
181. Fourth fall	30	640							
181. Eighth fall	34	730							
182. Moon chute	10	765							
182. Bala fall	20	1,530							

Muskoka river, South branch:									
183. South fall	115	2,700	.....	600	600	.....	.....	600	Electrical energy is transmitted 8 miles to Gravenhurst municipal plant
184. Catwohey fall	35	820	.....	.....	.....	.....	.....	.....	
Muskoka river, North branch:									
185. Bracebridge fall	51	1,530	.....	700	.....	.....	400	1,100	Municipal electric light plant; manufacturing of woollens and leather
185. Wolfram fall	41	1,230	400	700	1,100	.....	.....	1,100	Municipal electric plant, transmits energy to Bracebridge, 1 mile distant
186. High fall	44	1,320	.....	.....	.....	.....	.....	.....	

ONTARIO

DISTRICT No. VII.—TRIBUTARIES OF NORTH GEORGIAN BAY AND LAKE SUPERIOR

	Power Site	Minimum		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				REMARKS
		Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
Seguin river:										
187.	Parry Sound	15	140	.....	.....	.....	.....	240	240	Parry Sound Lumber Co.
	" "	20	160	140	260	500	.....	.....	500	Electric lighting plant
Maganetawan river:										
188.	Rapids above Byng Inlet.	10	340	.....	.....	.....	.....	.....	.....	
	Chute.	15	510	.....	.....	.....	.....	.....	.....	
189.	Farm Rapids chute.	49 6	1,500	.....	.....	.....	.....	.....	.....	
	E. Snye dam.	14	380	.....	.....	.....	.....	.....	.....	
	Mountain portage.	8	220	.....	.....	.....	.....	.....	.....	
190.	Canal rapids. Deer Lake dam.	18 9	740	.....	.....	.....	.....	.....	.....	
191.	Lower Burnt chute.	38	900	.....	.....	.....	.....	.....	.....	
	Upper Burnt chute.	30	710	.....	.....	.....	.....	.....	.....	
192.	Jacob rapid	15	340	.....	.....	.....	.....	.....	.....	
	Ross rapid	7	150	.....	.....	.....	.....	.....	.....	
	Poverty Bay rapids.	19	410	.....	.....	.....	.....	.....	.....	
	Ahmic Lake dam and Knee-opfle rapid	22	480	.....	.....	.....	.....	75	75	Croft Lumber Co
193.	Maganetawan.	10	130	.....	.....	.....	.....	100	100	Grist and lumber mill
194.	Burks Falls	28	250	.....	.....	.....	.....	500	500	Knight Bros., lumber mill
Maganetawan river, North branch:										
194.	Burks Falls	23	80	.....	.....	.....	.....	.....	.....	

French river:									
195. Dalles rapid	4½								
196. Recollet	7	1,000							
197. Five-mile rapid	19	2,750							
198. Chaudière	25	3,650							
South river:									
199. Chapman chute and rapid	27	270							
199. McNab chute	95	780		500	1,600			1,600	Electrical energy transmitted 20 m to North Bay by Nipissing Power Co.
199. Campbell chute									
200. Powassan chute	32	260							
200. Ragged chute	22	180							
201. South River station	70	250							
Trout creek (*tributary of South river*):									
202. Trout creek	30						75	75	Lumber mill
Sturgeon river:									
203. Sturgeon fall	38	3,150				6,600		6,600	Imperial Paper Co.
204. Sandy fall	8	660							
205. Smoky fall	28	2,140							
Wanapitei river:									
206. Second township	35	1,600							
206. " "	37	1,600							
207. Wanapitei, 10 mi. from Sudbury	54	2,000	1,350	320	2,500			2,500	Wanapitei Power Co.
Spanish river:									
208. Espanola	62	10,145				12,000		12,000	Spanish R. Pulp & Paper Co.
209. Nairn fall	28	2,620							
210. High fall	85	7,936	2,750	134	8,000			8,000	Huronian Co.; subsidiary of Can. Copper Co.
210. Norway fall and rapids	40	3,400							Lot 9, Con. I, Hyman
211. Township No. 108	14	1,190							Above Agnes river
212. Township No. 108	32	2,429							Below Agnes river
213. Metagama rapids, near Metagama station	27	980							
213.	16	580							
214. Biskotasi	26	630							

Power Site	Minimum		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				REMARKS
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
Vermilion river:									
215. Wabageshik rapid	15	980							
215. " chute	50	2,750	1,650		4,400			4,400	Mond Nickel Co.; electrical energy transmitted to Victoria Mines
216. Soo Branch crossing	15	955							
217. Island rapids	11	667							
217. Cascade	19	1,150							
218. MacPherson fall	26	2,040			1,700			1,700	Sudbury Power Co.
219. C. P. R. crossing	11	500							
219. Larchwood	9	410							
220. Onwatin lake	18	313							
Onaping river:									
221. High fall	127	3,460							
221. Fall	15	410							
222. Fall and rapids	22	480							
223. Rapids	17	278							
224. Onaping chute, outlet	11	147							
Whitefish river:									
225. Whitefish falls	47	500							At mouth of river
225. Charlton	58	450							
225. Long lake	16	116							Combined with 9 ft. fall
Sable river:									
226. Bridge rapids	8	167							
226. Spanish chute	38.5	805							½ mile from Massey
226. Graveyard chute	54	1,130							

227.	Island rapid	16	334							
	Crooked rapid	19	397							
	Meareau rapid	36	755							
228.	Cameron fall	45	940							
229.	Long rapid	16	334							
	Ragged rapid	24	435							
230.	McKee fall	39	567							
	High fall	51	603							
Serpent river:										
231.	McCarthy chute	61	855							
	1st Log-slide	63	800							
	2nd " "	36	460							
	3rd " "	26	330							
	4th " "	19	242							
232.	Fall and rapids below Whiskey lake	35	128							
233.	Rapids at Big Bear lake	32	116							
Blind river:										
234.	Blind river	12	150					300	300	White Pine Lumber Co; uses steam auxiliary
	Cataract fall	23	182							
235.	White fall	55	435							7¼ miles from Blind river
	High fall	31	245							
	Chiblow Lake outlet	45	356							
Mississagi river:										
236.	1st fall	20	1,910							
	2nd fall	21	2,000							
	Slate fall	32	3,045							Lot No. 12, Con. 6, Gladstone
237.	4th fall	18	1,390							
	5th fall	31	2,400							
	Squaw chute	17.5	1,350							
238.	Aubrey fall and rapids	117	7,980							
239.	Fall	24	915							
240.	Head of lake Minnisagua	13	425							
241.	Fall	21	342							
	Head of fall	38	555							

DISTRICT No. VII.—TRIBUTARIES OF NORTH GEORGIAN BAY AND LAKE SUPERIOR—*Continued*

Power Site	Minimum		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				REMARKS
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
White river:									
242. Bell fall	17	327	.....	.....	.....	.....	.....	.....	
White fall	16	145	.....	.....	.....	.....	.....	.....	
Wright river:									
243. Sylvan Valley	9	50	.....	.....	.....	.....	50	50	Grist mill
St. Mary river:									
244. St. Mary rapid	18	98,200	3,100	1,400	4,500	9,800	350	14,650	Lake Superior Power Co.
Goulais river:									
245. Lower fall	61	1,109	.....	.....	.....	.....	.....	.....	
Upper fall	52	591	.....	.....	.....	.....	.....	.....	
Chippawa river:									
246. Fall at mouth	61	470	.....	.....	.....	.....	.....	.....	
Batchawana river:									
247. Fall at mouth	34	340	.....	.....	.....	.....	.....	.....	Artificial head
2nd fall	35	350	.....	.....	.....	.....	.....	.....	
Montreal river:									
248. Fall at mouth	165	5,100	.....	.....	.....	.....	.....	.....	
249. Upper fall	170	5,250	.....	.....	.....	.....	.....	.....	

Agawa river:									
250. Fall at mouth	90	1,430							Including backing up on rapids 10 ft.
Michipicoten river:									
251. High fall	128	7,564	570	30	1,700			1,700	Algoma Power Co.
252. Cat Portage fall	33	1,068							
253. Pigeon fall	18	585							
254. Stony portage fall	91	1,940							
Shikwamkwa river:									
255. First fall	27	715							First and second falls would be combined by means of a dam at first fall
255. Second fall	22	585							
255. Third fall	32	697							
Magpie river:									
256. 1st 2nd and 3rd falls	113	2,630							At mouth of river
257. 4th fall	77	1,790							
258. 5th fall	63	1,470							Four miles from Helen mine
Dog river:									
259. Denison falls	140	1,590							
White river:									
260. 1st fall	50	2,280							6 miles from lake Superior
260. 2nd fall	40	1,820							6½ " " " "
260. 3rd fall	20	910							6¾ " " " "
261. 4th fall	35	1,590							11¼ " " " "
261. 5th fall	20	820							11¾ " " " "
261. 6th fall	145	5,950							12¼ " " " "
261. 7th fall	50	2,046							13¼ " " " "
262. 8th fall	50	1,360							32 " " " "
263. 9th fall	20	545							27 " below Montizambert
263. 10th fall	33	750							25 " " "
264. 11th fall	20	410							15 miles below Montizambert
Pic river:									
265. Lake Superior portage	51	650							60 miles from lake Superior
266. White Otter fall	42	495							
267. Sandhill portage	115	1,360							

DISTRICT No. VII.—TRIBUTARIES OF NORTH GEORGIAN BAY AND LAKE SUPERIOR—*Continued*

Power Site	Minimum		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				REMARKS
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
Steel river:									
268. Simpson stretch	71	970							7 miles from Jackfish
Black river:									
269. Falls at mouth	106	725							7 miles east of Schreiber
Nipigon river:									
270. Cameron rapid	39	19,500							14 miles from Nipigon station
271. Split-rock	15	7,500							
271. Island portage	9.5	4,750							
271. Pine portage rapid									
271. White chute	12	6,000							
271. Flat-rock rapid	38	19,000							
271. Victoria rapid	10	5,000							
271. Camp Miner rapid	7	3,500							
271. Virgin fall	25	12,500							30 miles from Nipigon station
ipigon tributaries:									
272. Mamewaminikan river, Nogominon	42	955							Adjacent to iron deposits
273. Mamewaminikan river, Beaver falls	28	635							
274. Onaman river									No valuable water-power
275. Ombabika river									Good storage, but no valuable natural water-power
276. Pikitigushi river									Not developed
277. Wabinosh river									" "
278. Gull river									" "

279. Black Sturgeon river	150	.....	.....	.....	.....	.....	.....	.....	
Wolf river:									
280. First fall	30	270	.....	.....	.....	.....	.....	.....	
280. Second fall	42	380	.....	.....	.....	.....	.....	.....	
Current river:									
281. Falls at mouth	86	1,020	1,000	800	1,800	.....	.....	1,800	Port Arthur municipal plant; 75% deficiency at low water; also receives current from Kakabeka fall
281. Cascades	100	910	.....	.....	.....	.....	.....	.....	
Kaministikwia river;									
282. Mt. McKay and Kakabeka falls Ry	25	1,887	.....	.....	.....	.....	.....	.....	Lot 2. Block A, Paipoonge
283. Kakabeka fall and Ecarte rapid	180	13,100	8,000	2,000	25,000	.....	.....	25,000	Kaministikwia Power Co., supplying energy to Fort William and Port Arthur
284. Rapids	10	728	.....	.....	.....	.....	.....	.....	
284. Rapids	33	1,350	.....	.....	.....	.....	.....	.....	
285. Dog fall	347	14,200	.....	.....	.....	.....	.....	.....	25 miles from Port Arthur; development not complete; only dams put in.
Pigeon river:									
286. High fall	110	1,250	.....	.....	.....	.....	.....	.....	At mouth of river
286. Cascades	100	545	.....	.....	.....	.....	.....	.....	
Arrow river:									
287. High fall	37	202	.....	.....	.....	.....	.....	.....	At mouth of river

ONTARIO

DISTRICT No. VIII.—WINNIPEG AND ENGLISH RIVERS AND THEIR TRIBUTARIES

Power Site	Minimum		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				REMARKS
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
Seine river:									
288. Seine fall	11	800	.....	.....	.....	.....	.....	.....	
289. Island fall	20	1,510	.....	.....	.....	.....	.....	.....	Minto mine adjacent
289. Lynx Head chute	11	880	.....	.....	.....	.....	.....	.....	
289. Steep Rock fall	40	2,900	.....	.....	.....	.....	.....	.....	
290. Sturgeon fall	13	1,320	.....	.....	.....	.....	.....	.....	
Rainy river:									
291. Fort Frances, Koochiching fall	23	14,000	.....	.....	7,000	.....	.....	7,000	The hydraulic part of the total development has been completed. Of this, 12,000 H.P. is being utilized on the U.S. side for the manufacture of pulp. On the Canadian side, there is an electric installation of 7,000 H.P. capacity, half of which is temporarily permitted to be exported to the U.S. Some 500 H.P. are used in Fort Frances
Winnipeg river:									
292. East branch, Kenora	18	4,100	1,318	750	2,500	.....	.....	2,500	Corporation of Kenora electric plant
292. West branch, Kenora	18	18,000	.....	.....	.....	.....	3,800	3,800	Lake of Woods Milling Co.
293. Island fall	45	59,300	.....	.....	.....	.....	.....	.....	Combined artificial head

Wabigoon river:										
294.	Upper fall, Dryden	26	568							
	Lower rapid, Dryden	22	480							
English river:										
295.	Pelican chute	12	3,490							
296.	Ear rapid	29	16,100							Combined artificial head
297.	Manitou chute	28	17,800							
	Fall	15	9,670							
298.	Rapid	6	3,980							
	Fall	10	6,820							
	Rapid	6	4,360							
	Rapd	6	4,910							
299.	Kettle fall	19	15,550							
	Rapid	15	12,250							
300.	Caribou rapid	6	5,050							

ONTARIO

DISTRICT No. IX.—JAMES BAY SLOPE

Power Site	Natural head (in feet)	Approximate drainage basin area (sq. mi.)	Estimated minimum flow, (c. f. s.)	Estimated mean discharge under controlled storage (c. f. s.)	Minimum 24 hr. H.P. under natural flow	Minimum 24 hr. H.P. under discharge control
Albany river:						
301. Martin fall	30	.....	.....	.....	17,800	44,600
Ogoki river:						
302. Amy fall	30	8,000	3,200	8,000	10,800	27,000
303. Rapids below Amy fall	10	8,000	3,200	8,000	3,600	9,000
304. Burton fall	50	12,000	4,800	12,000	27,200	68,000
305. Rapids above mouth of Whitefish river	50	12,000	4,800	12,000	27,200	68,000
Kenogami river:						
306. Kenogami fall	25	1,000	400	1,000	1,100	2,800
307. 3rd Portage fall	25	1,500	600	1,500	1,700	4,200
308. 7th Portage fall	32	1,800	720	1,800	2,600	6,500
309. 10th Portage fall	12	2,300	920	2,300	1,200	3,000
310. 11th Portage fall	70	3,500	1,000	2,500	8,000	20,000
Kawashkagama river:						
310a Upper fall	14	.....	.....	.....	127	.....
Howard fall	21	.....	.....	.....	190	.....
Kabinakagami river:						
311. 1st Outlet fall	35	1,000	400	1,000	1,600	4,000
311. 2nd fall and rapids	25	1,100	440	1,100	1,200	3,000
312. 3rd fall and rapids	15	1,200	480	1,200	800	2,000
312. 4th fall and rapids	20	1,400	560	1,400	1,200	3,000
312. 5th fall and rapids	40	1,500	600	1,500	2,700	6,800
313. 6th fall and rapids	12	1,600	640	1,600	800	2,200
313. 7th fall and rapids	25	1,700	680	1,700	1,900	4,800
314. 8th and 9th falls and rapids	18	1,800	720	1,800	1,400	3,600
314. 10th fall and rapids	30	2,000	800	2,000	2,700	6,800
314. 11th, 12th and 13th falls and rapids	75	2,100	820	2,100	7,400	18,700
315. 14th fall and rapids	10	2,300	920	2,300	1,000	2,600
316. 15th fall and rapids	17	2,500	1,000	2,500	1,900	4,800

DISTRICT No. IX.—JAMES BAY SLOPE—*Continued*

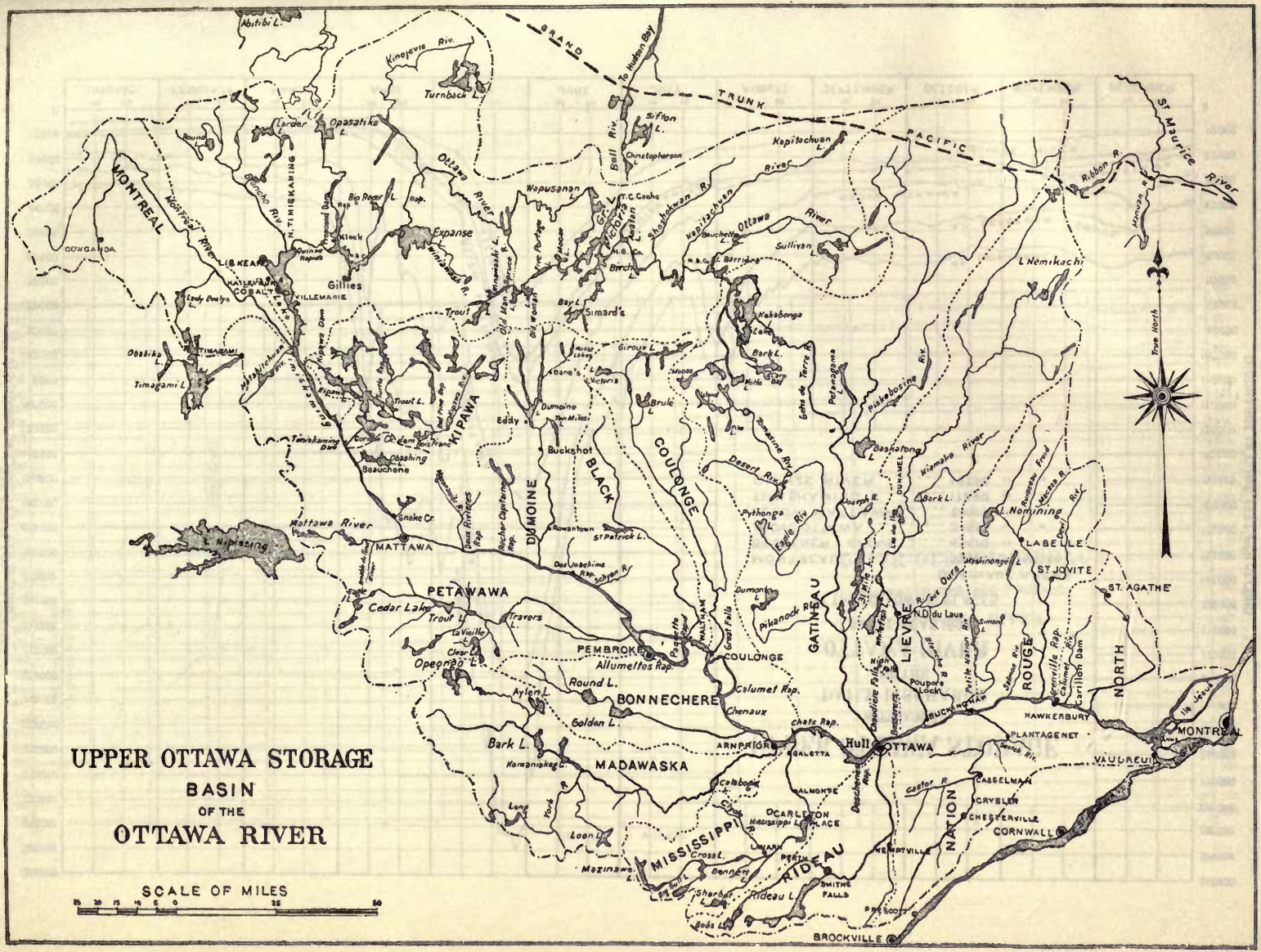
Power Site	Natural head (in feet)	Approximate drainage basin area (sq. mi.)	Estimated minimum flow, (c. f. s.)	Estimated mean discharge under controlled storage (c. f. s.)	Minimum 24 hr. H.P. under natural flow	Minimum 24 hr. H.P. under discharge control
Missinaibi river:						
317. Brunswick rapids.	10	2,500	1,000	2,500	1,000	2,600
317. Green Hill rapids.	10	2,500	1,000	2,500	1,000	2,600
318. St. Peter fall	15	3,000	1,200	3,000	2,000	5,100
319. St. Paul fall	20	3,000	1,200	3,000	2,700	6,800
320. Albany rapid	10	4,500	1,800	4,500	2,000	5,100
321. Beaver portage	12	5,000	2,000	5,000	2,700	6,800
321. Sharp Rock fall	10	5,000	2,000	5,000	2,200	5,600
322. Crow rapid	17	5,500	2,200	5,500	4,200	10,500
323. Island chute	10	5,500	2,200	5,500	2,500	6,200
324. Tom King and Kettle rapids	20	6,000	2,400	6,000	5,400	13,600
325. Conjuror chute and Hell Gate	250	6,500	2,600	6,500	73,800	184,600
Opazatika river:						
326. Breakneck fall and rapid above	150	2,500	1,000	2,500	17,000	42,600
Mattagami river:						
327. Kenogamisi fall and rapids[a]	40	1,000	400	1,000	1,800	4,500
328. Wawatian fall	116	1,000	400	1,000	5,200	13,000
329. Sandy fall,[b] Mountjoy tp.	50	2,500	1,000	2,500	5,600	14,000
330. Sturgeon fall, Mahaffy tp.	16	3,500	1,400	3,500	2,500	6,300
331. Yellow fall, Bradburn tp.	18	3,500	1,400	3,500	2,800	7,100
331. Island fall, Bradburn tp.	17	3,500	1,400	3,500	2,700	6,700
332. Smooth-rock fall, Kendry tp.	22	4,000	1,600	4,000	4,000	10,000
333. Fish rapid	15	4,000	1,600	4,000	2,700	6,800
334. Cypress fall	20	4,500	1,800	4,500	4,000	10,100
335. Devil fall	12	12,000	4,800	12,000	6,400	16,200
336 Little Long fall and rapids	80	12,000	4,800	12,000	43,200	108,000
336 Great rapids, Long portage	100	12,000	4,800	12,000	54,000	135,000
336 Grand rapid	40	12,500	5,000	12,500	22,000	56,800
337. Long Rapid fall	150	12,500	5,000	12,500	85,200	213,000
338. Forks fall	10	12,500	5,000	12,500	5,700	14,200

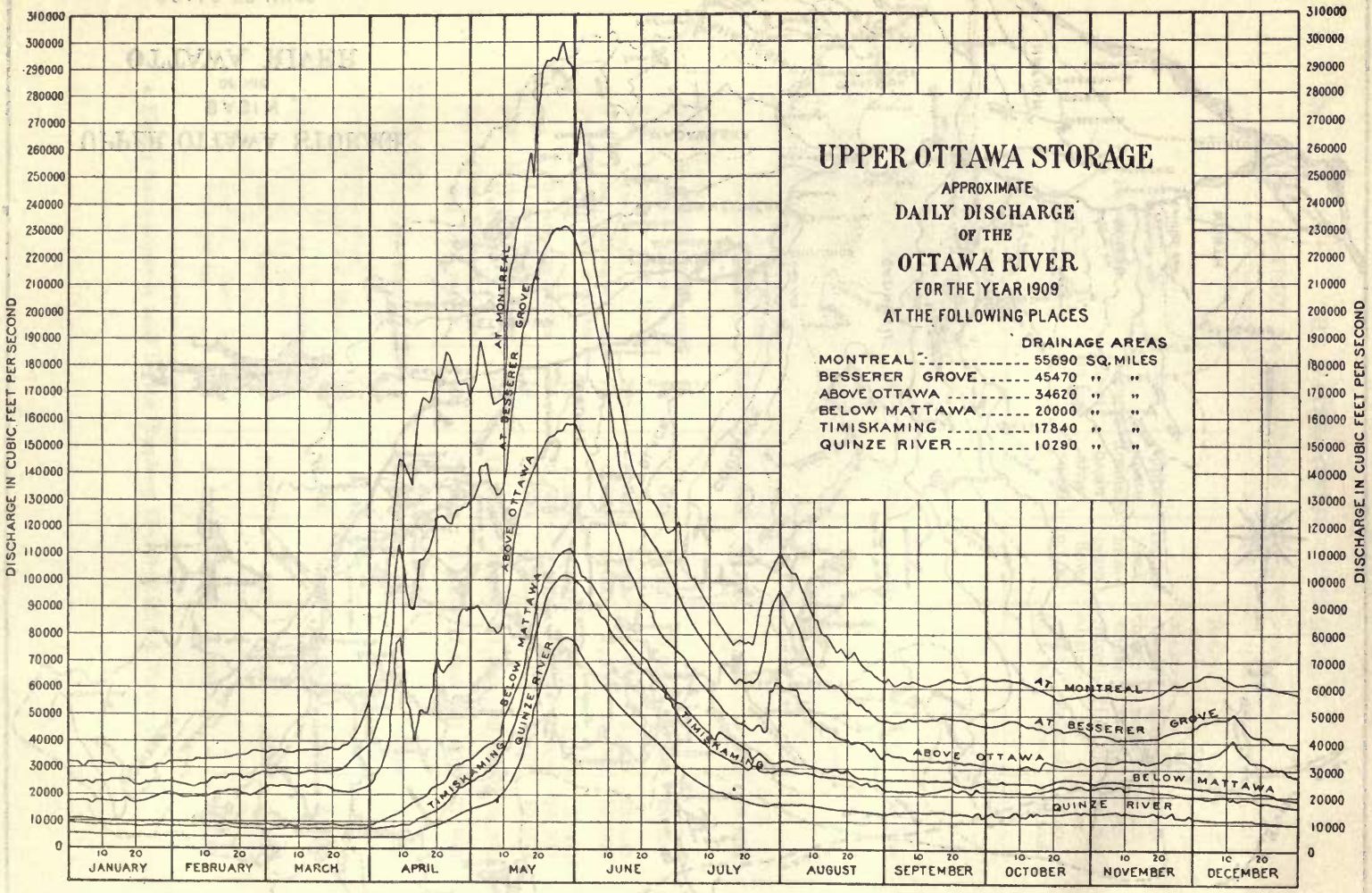
[a] Walberg development. Contract awarded for 2 wheels, 3,500 H.P., each.
[b] This development contains 2 units of 1,500 H.P. each; 12,000 volts transmission.

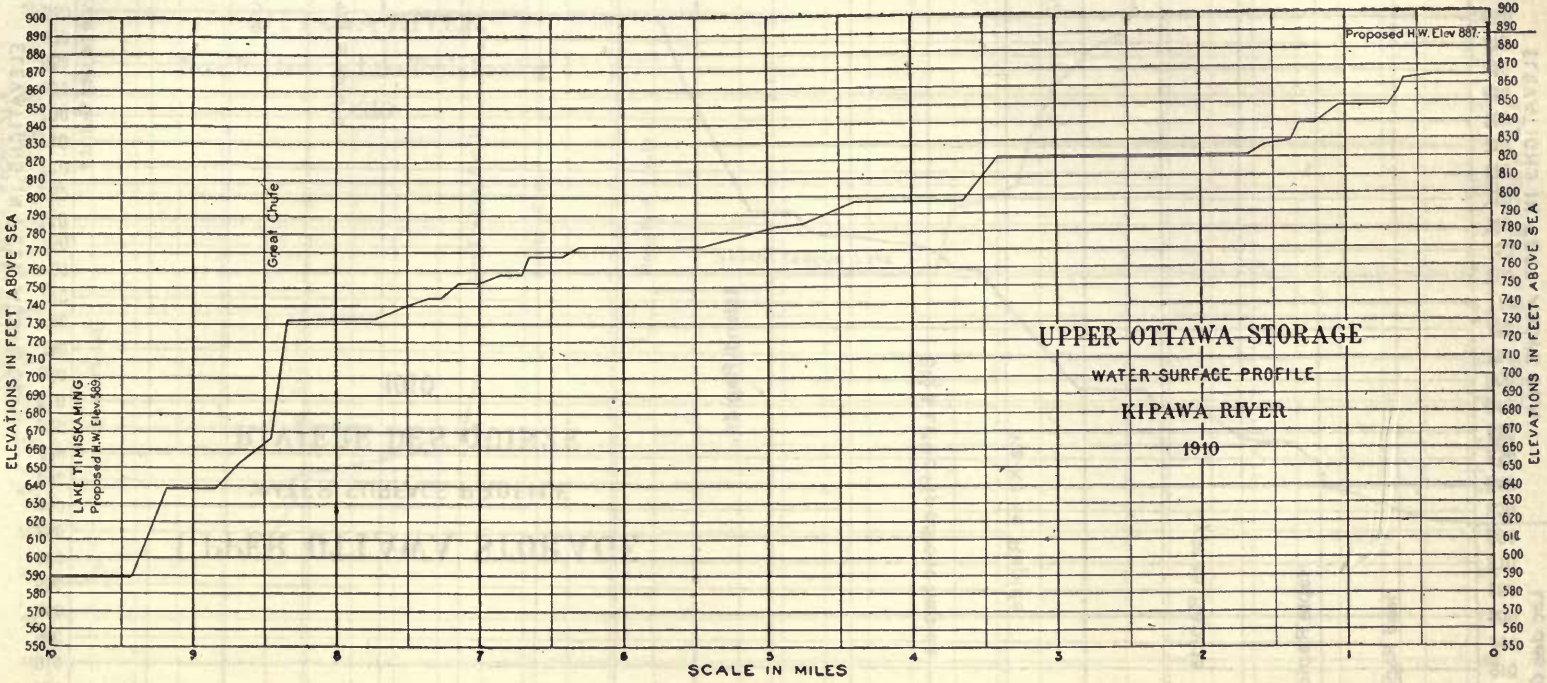
DISTRICT No. IX.—JAMES BAY SLOPE—*Continued*

Power Site	Natural head (in feet)	Approximate drainage basin area (sq.mi.)	Estimated minimum flow, (c.f.s.)	Estimated mean discharge under controlled storage (c. f. s.)	Minimum 24 hr. H.P. under natural flow	Minimum 24 hr. H.P. under charge control
Kapuskasing river:						
339. Series of falls and rapids south of Niven's base line aggregating.	80	3,200	1,280	3,200	11,500	28,800
Kebsquashing river:						
339a. Chapleau.	33	. . . . .	. . . . .	. . . . .	250[a]	. . . . .
Kakozhisk river:						
340. Series of falls and rapids south of Niven's base line. . .	100	4,400	1,760	4,400	19,800	49,600
Abitibi river:						
341. Koochiching fall and rapids below.	50	5,000	2,000	5,000	11,000	28,000
342. Iroquois and Buck Deer falls.	20	6,000	2,400	6,000	5,400	13,500
343. Long Sault rapid	75	6,500	2,600	7,500	22,000	55,000
344. Kettle fall and rapids.	10	7,000	2,800	7,000	3,200	8,000
345. 3-Carrying rapids.	25	9,500	3,800	9,500	10,600	26,500
345. Lobstick rapids. ..	15	9,500	3,800	9,500	6,400	16,000
346. Series of rapids above New Post.	100	11,000	4,400	11,000	49,600	124,000
347. Otter, Sextant, Coral and Long rapids. .	60	12,000	4,800	12,000	31,000	77,500
Black river:						
348. McDougall chute. . .	14	800	320	800	500	1,260
Frederickhouse river:						
349. High fall, Mann. tp.	40	1,000	400	1,000	1,800	4,500
349. Fall and rapids, Lot 12, Cons. 4 and 5, Mann tp. .	30	1,000	400	1,000	1,350	3,400
350. Rapids on Lots 11 and 12, Con. 5, Fournier tp.	12	1,200	480	1,200		1,640

[a] Eighty horse-power is used by the Chapleau Electric Light & Power Co.


UPPER OTTAWA STORAGE
BASIN
OF THE
OTTAWA RIVER
SCALE OF MILES
Abitibi L.
Kinojevis Riv.
Turnback L.
Opasatika L.
Larder
Round L.
Blanche Riv.
N. TIMISKAMING
MONTREAL
Montreal River
COWGANDA
LIBKEA
HAILEYBURY
GORALT
LAKE
Lady Evelyn L.
Obabika L.
Timagami L.
Timagami
Gillies
VILLEMARIE
Quinze Rapids
Big Rocky L.
Klock
Expanse
Wanapitei R.
Trout
Bay L.
Simard's
Ottawa River
Wapusanan L.
Grand Lake Victoria
Lake Dufay
Lake Travers
Old Woman L.
Old Man L.
Spruce R.
Kipawa
Trout L.
Eddy
Dumoine
Ten Miles
Buckshot
Obashing
Beauchene
Tomiskaming Dam
Ch. dam
Fiftyone
Fifteen
Gowganda Riv.
Montreal River Dam
Wabi Riv.
Wabi Falls
Wabi Rapids
Wabitibikwe R.
Wabitibikwe Falls
Wabitibikwe Lake
Snake Cr.
Wattawa River
L. Nipissing
MATTAWA
Mattawa Falls
Rocher Capitaine Rap.
Deux Rivieres
Deux Rivieres Rap.
Des Joachims Rap.
Ottawa R.
DUMOINE
BLACK
COULONGE
Rowantown
St Patrick L.
PETAWAWA
Cedar Lake
Trout L.
Travers
Opeongo L.
Clear L.
La Vieille L.
PEMBROKE
Allumettes Rap.
Petawawa R.
Waltham
Great Falls
Round L.
BONNECHERE
Golden L.
Ayton L.
Bark L.
Kamaniskeg L.
MADAWASKA
Lang
Ford
Loon L.
Mazinaw L.
Crosst.
MISSISSIPPI
Bennett
Sharbot L.
Jebb L.
Rideau L.
RIDEAU
SMITHS FALLS
BROCKVILLE
Gibson L.
Kapitachuan L.
Sifton L.
Christopherson
Bell Riv.
To Hudson Bay
TRUNK
PACIFIC
River
Shabotwan R.
Vapitachwan
Ottawa River
Bouchette L.
Sullivan L.
Barriere
Birch L.
Kakabonga L.
Bark L.
Goose Bay
Hills
Moose
Brule L.
Girouy L.
Victoria
Lake de Terre Rouge
Petawagama L.
Pistabosine R.
L. Nemikachi
Ribbon R.
St. Maurice River
Manouan R.
True North
Baskatong L.
Kiamika River
DUNNEL
Bark L.
Desert River
Tomasine
Pythonga L.
Eagle Riv.
Joseph R.
Dumoine L.
Pikanock R.
GATINEAU
L. Nominingue
Nominingue R.
Rouge R.
LABELLE
Mashinonge L.
ST JOVITE
ST. AGATHE
Simon L.
N.D. du Laus
Petite Nation R.
Petite Nation Riv.
Poupore Lock
LIEVRE
Buckingham
Chaudiere Falls
Chaudiere Rap.
Hull
OTTAWA
Gatineau R.
Carillon Rap.
Carillon Dam
ROUGE
NORTH
Ile Jesus
MONTREAL
HAWKESBURY
PLANTAGENET
Seaton Riv.
VAUDREUIL
Castor R.
CASSELMAN
CRYSLER
CHESTERVILLE
CORNWALL
NATION
HEMMINGFORD
ARNPRIOR
GALETTA
ALMONTE
Clyde R.
Clyde
Deschenes Rap.
OCARLETON PLACE
Mississippi L.
Mississippi R.
Indian R.
PERTH
Tay R.
Rideau Falls
Jones Falls
Chaudiere Falls
Chats Rap.
Chenaux
Columet Rap.
Allumettes Rap.
Petawawa R.
Waltham
Great Falls
Pikanock R.
Dumoine L.
Joseph R.
Eagle Riv.
Pythonga L.
Desert River
Tomasine
Baskatong L.
Kiamika River
DUNNEL
Bark L.
L. Nominingue
Nominingue R.
Rouge R.
LABELLE
Mashinonge L.
ST JOVITE
ST. AGATHE
Simon L.
N.D. du Laus
Petite Nation R.
Petite Nation Riv.
Poupore Lock
LIEVRE
Buckingham
Chaudiere Falls
Chaudiere Rap.
Hull
OTTAWA
Gatineau R.
Carillon Rap.
Carillon Dam
ROUGE
NORTH
Ile Jesus
MONTREAL
HAWKESBURY
PLANTAGENET
Seaton Riv.
VAUDREUIL
Castor R.
CASSELMAN
CRYSLER
CHESTERVILLE
CORNWALL
NATION
HEMMINGFORD
ARNPRIOR
GALETTA
ALMONTE
Clyde R.
Clyde
Deschenes Rap.
OCARLETON PLACE
Mississippi L.
Mississippi R.
Indian R.
PERTH
Tay R.
Rideau Falls
Jones Falls
Chaudiere Falls
Chats Rap.
Chenaux
Columet Rap.
Allumettes Rap.
Petawawa R.
Waltham
Great Falls
Pikanock R.
Dumoine L.
Joseph R.
Eagle Riv.
Pythonga L.
Desert River
Tomasine
Baskatong L.
Kiamika River
DUNNEL
Bark L.
L. Nominingue
Nominingue R.
Rouge R.
LABELLE
Mashinonge L.
ST JOVITE
ST. AGATHE
Simon L.
N.D. du Laus
Petite Nation R.
Petite Nation Riv.
Poupore Lock
LIEVRE
Buckingham
Chaudiere Falls
Chaudiere Rap.
Hull
OTTAWA
Gatineau R.
Carillon Rap.
Carillon Dam
ROUGE
NORTH
Ile Jesus
MONTREAL
HAWKESBURY
PLANTAGENET
Seaton Riv.
VAUDREUIL
Castor R.
CASSELMAN
CRYSLER
CHESTERVILLE
CORNWALL
NATION
HEMMINGFORD
ARNPRIOR
GALETTA
ALMONTE
Clyde R.
Clyde
Deschenes Rap.
OCARLETON PLACE
Mississippi L.
Mississippi R.
Indian R.
PERTH
Tay R.
Rideau Falls
Jones Falls


UPPER OTTAWA STORAGE
APPROXIMATE
DAILY DISCHARGE
OF THE
OTTAWA RIVER
FOR THE YEAR 1909
AT THE FOLLOWING PLACES
DRAINAGE AREAS
MONTREAL ..... 55690 SQ. MILES
BESSERER GROVE ..... 45470 " "
ABOVE OTTAWA ..... 34620 " "
BELOW MATTAWA ..... 20000 " "
TIMISKAMING ..... 17840 " "
QUINZE RIVER ..... 10290 " "
DISCHARGE IN CUBIC FEET PER SECOND
AT MONTREAL
AT BESSERER GROVE
ABOVE OTTAWA
BELOW MATTAWA
QUINZE RIVER
TIMISKAMING
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER

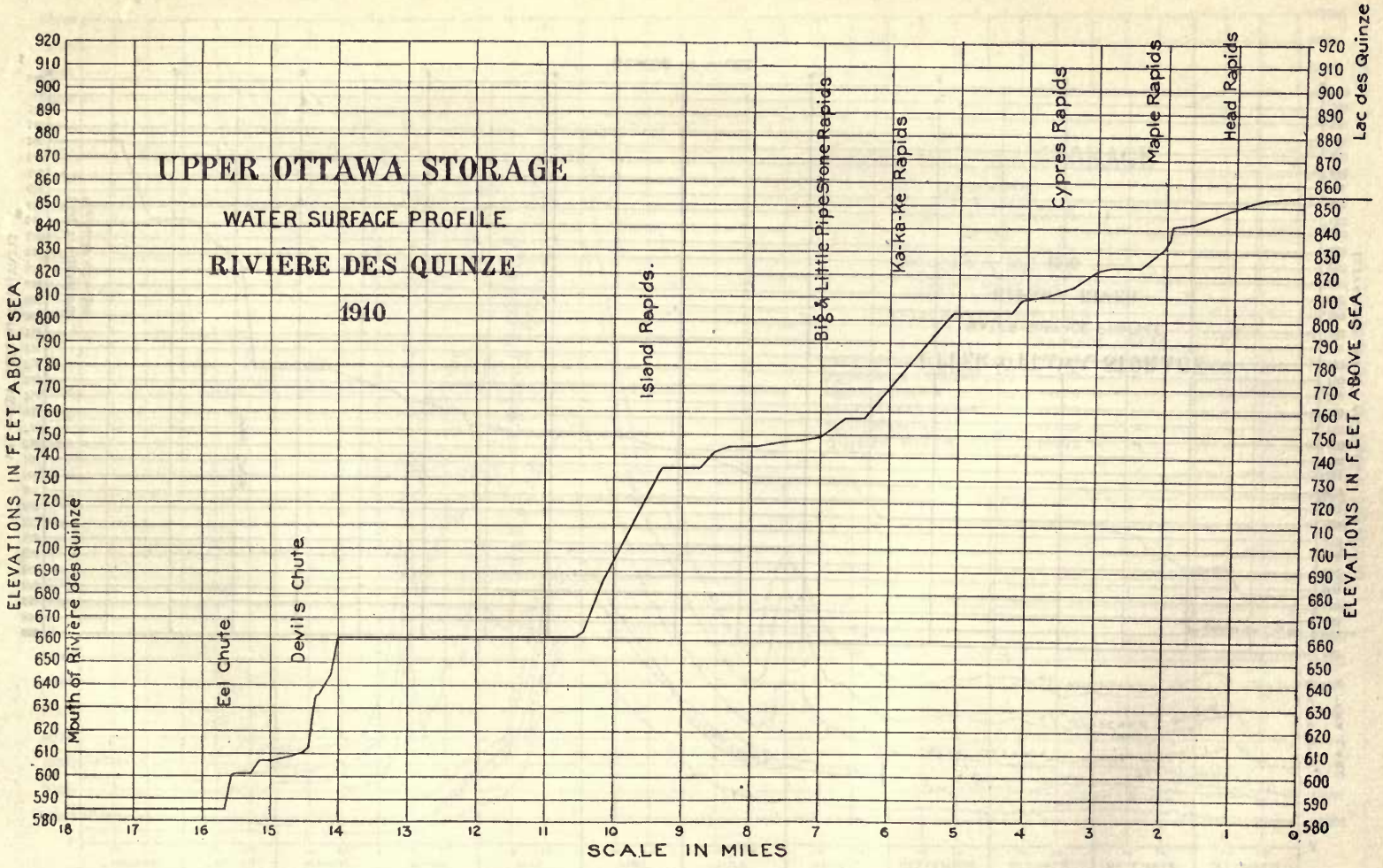


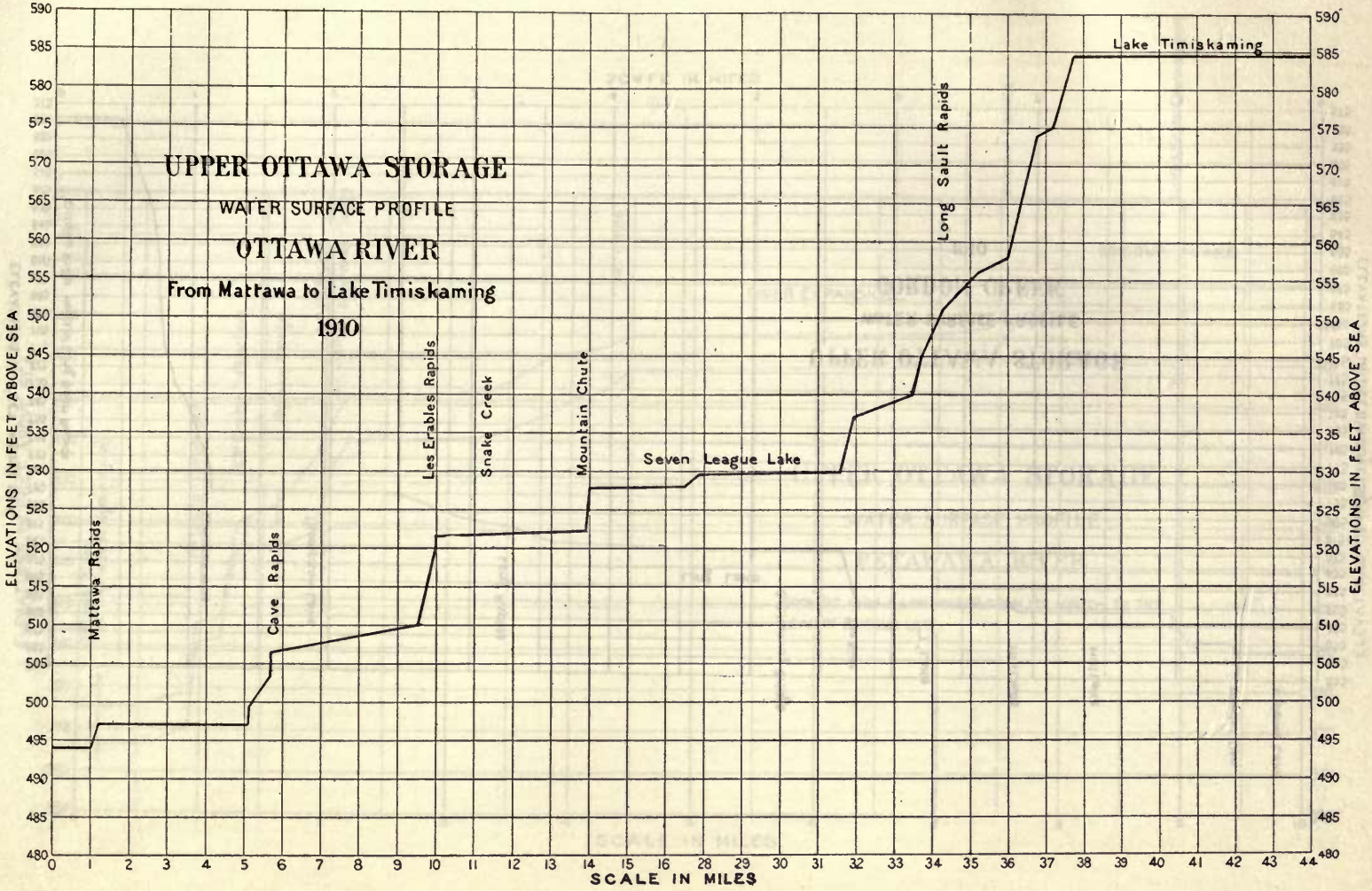
UPPER OTTAWA STORAGE

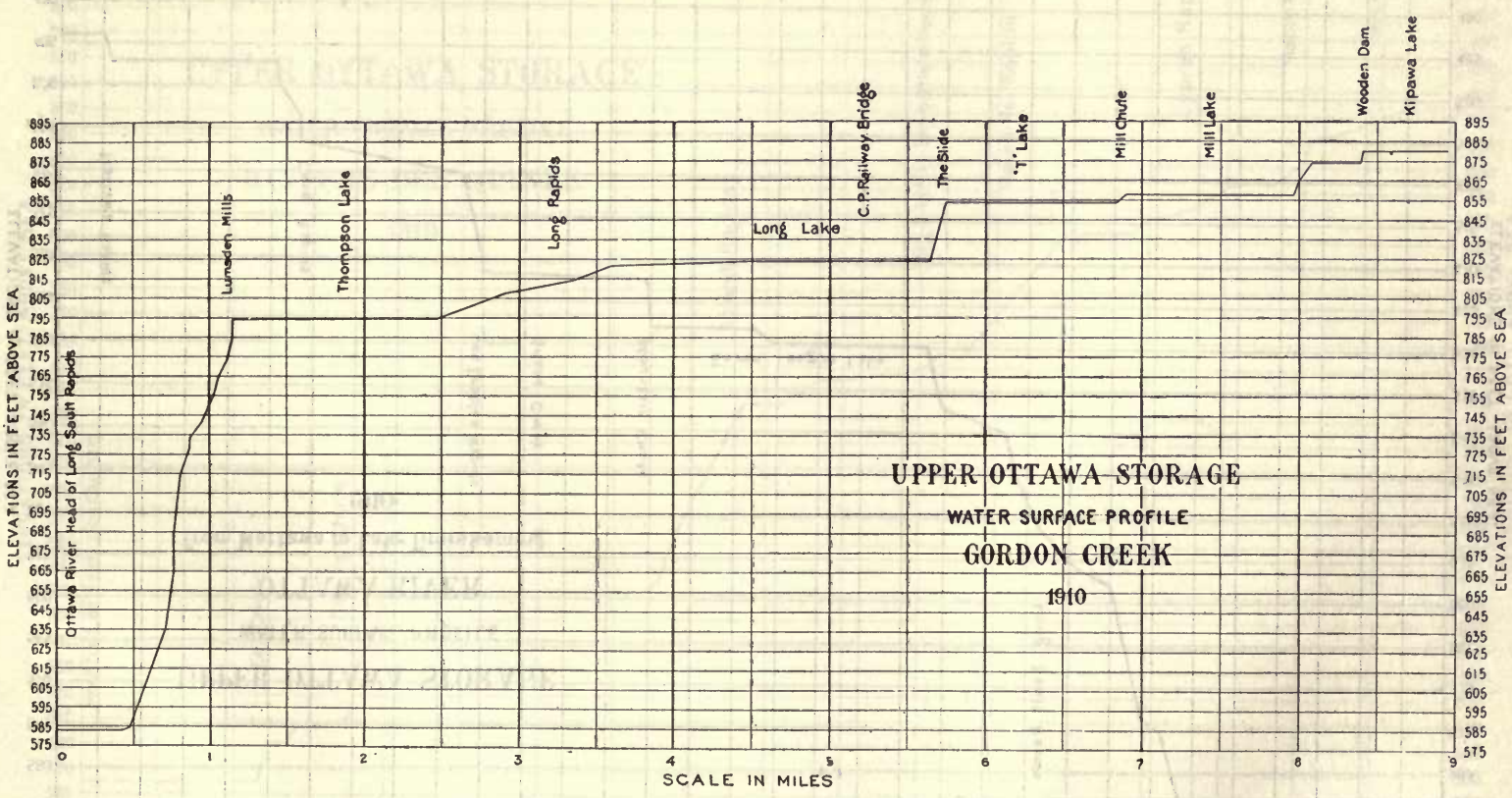
WATER-SURFACE PROFILE

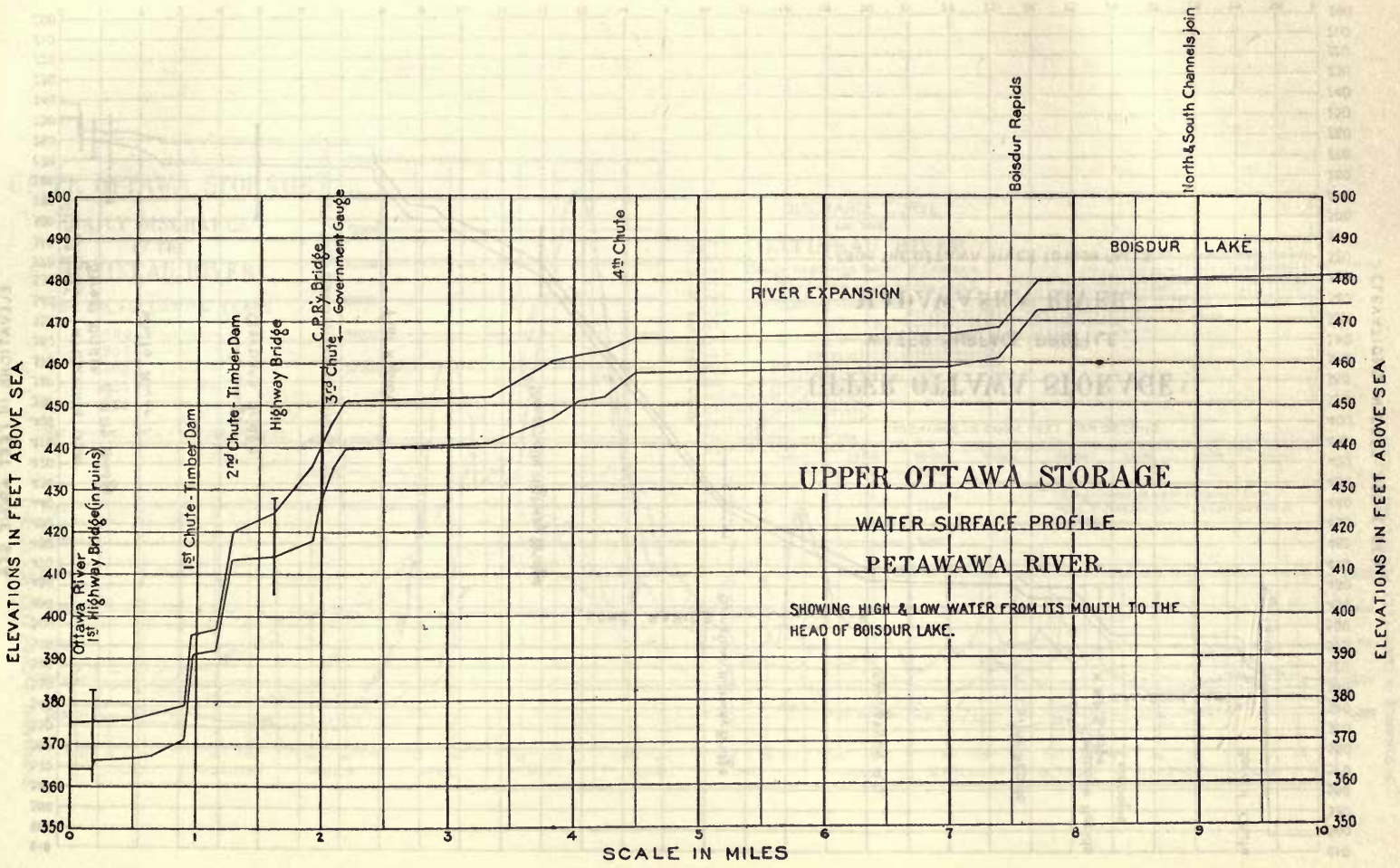
KIPAWA RIVER

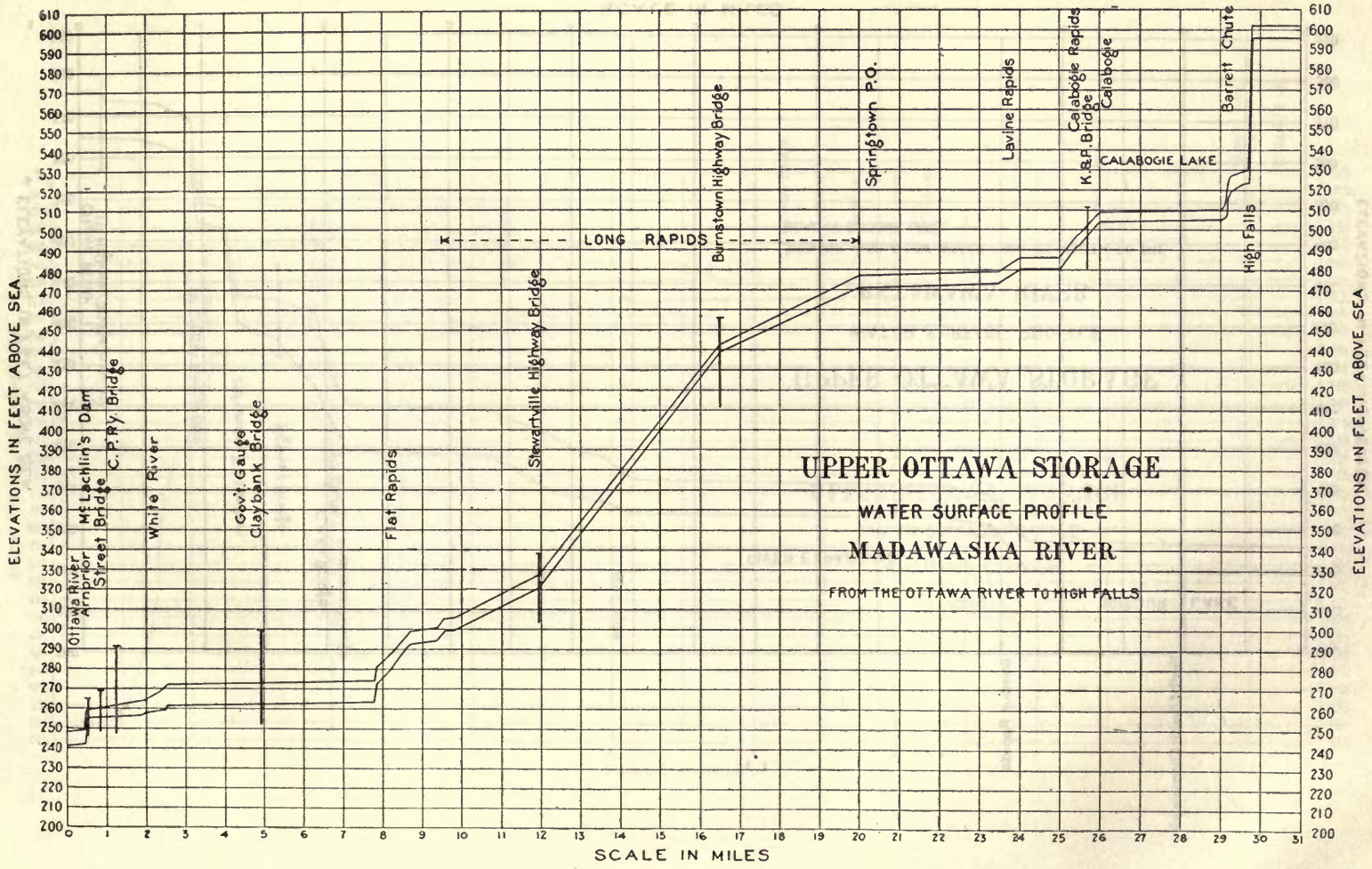
1910


UPPER OTTAWA STORAGE
WATER SURFACE PROFILE
RIVIERE DES QUINZE
1910
ELEVATIONS IN FEET ABOVE SEA
SCALE IN MILES
Mouth of Rivière des Quinze
Eel Chute
Devils Chute
Island Rapids.
Big & Little Pipestone Rapids
Ka-ka-ke Rapids
Cypres Rapids
Maple Rapids
Head Rapids
Lac des Quinze


UPPER OTTAWA STORAGE
WATER SURFACE PROFILE
OTTAWA RIVER
From Mattawa to Lake Timiskaming
1910
ELEVATIONS IN FEET ABOVE SEA
ELEVATIONS IN FEET ABOVE SEA
SCALE IN MILES
Mattawa Rapids
Cave Rapids
Les Erables Rapids
Snake Creek
Mountain Chute
Seven League Lake
Long Sault Rapids
Lake Timiskaming


ELEVATIONS IN FEET ABOVE SEA
Ottawa River Head of Long South Rapids
Lumsden Mills
Thompson Lake
Long Rapids
Long Lake
C.P. Railway Bridge
The Slide
"T" Lake
Mill Chute
Mill Lake
Wooden Dam
Kipawa Lake
UPPER OTTAWA STORAGE
WATER SURFACE PROFILE
GORDON CREEK
1910
SCALE IN MILES


UPPER OTTAWA STORAGE
WATER SURFACE PROFILE
PETAWAWA RIVER
SHOWING HIGH & LOW WATER FROM ITS MOUTH TO THE HEAD OF BOISDUR LAKE.
ELEVATIONS IN FEET ABOVE SEA
SCALE IN MILES
Ottawa River
1st Highway Bridge (in ruins)
1st Chute - Timber Dam
2nd Chute - Timber Dam
Highway Bridge
C.P.R.'y Bridge
Government Gauge
3rd Chute
4th Chute
RIVER EXPANSION
BOISDUR LAKE
Boisdur Rapids
North & South Channels join


UPPER OTTAWA STORAGE
WATER SURFACE PROFILE
MADAWASKA RIVER
FROM THE OTTAWA RIVER TO HIGH FALLS
ELEVATIONS IN FEET ABOVE SEA
SCALE IN MILES
LONG RAPIDS
Ottawa River
Arnprior
McLachlin's Dam
Street Bridge
C.P.Ry Bridge
White River
Gov't Gauge
Claybank Bridge
Flat Rapids
Stewartville Highway Bridge
Burnstown Highway Bridge
Springtown P.O.
Lavine Rapids
Calabogie Rapids
K.&P. Bridge
Calabogie
CALABOGIE LAKE
Barrett Chute
High Falls

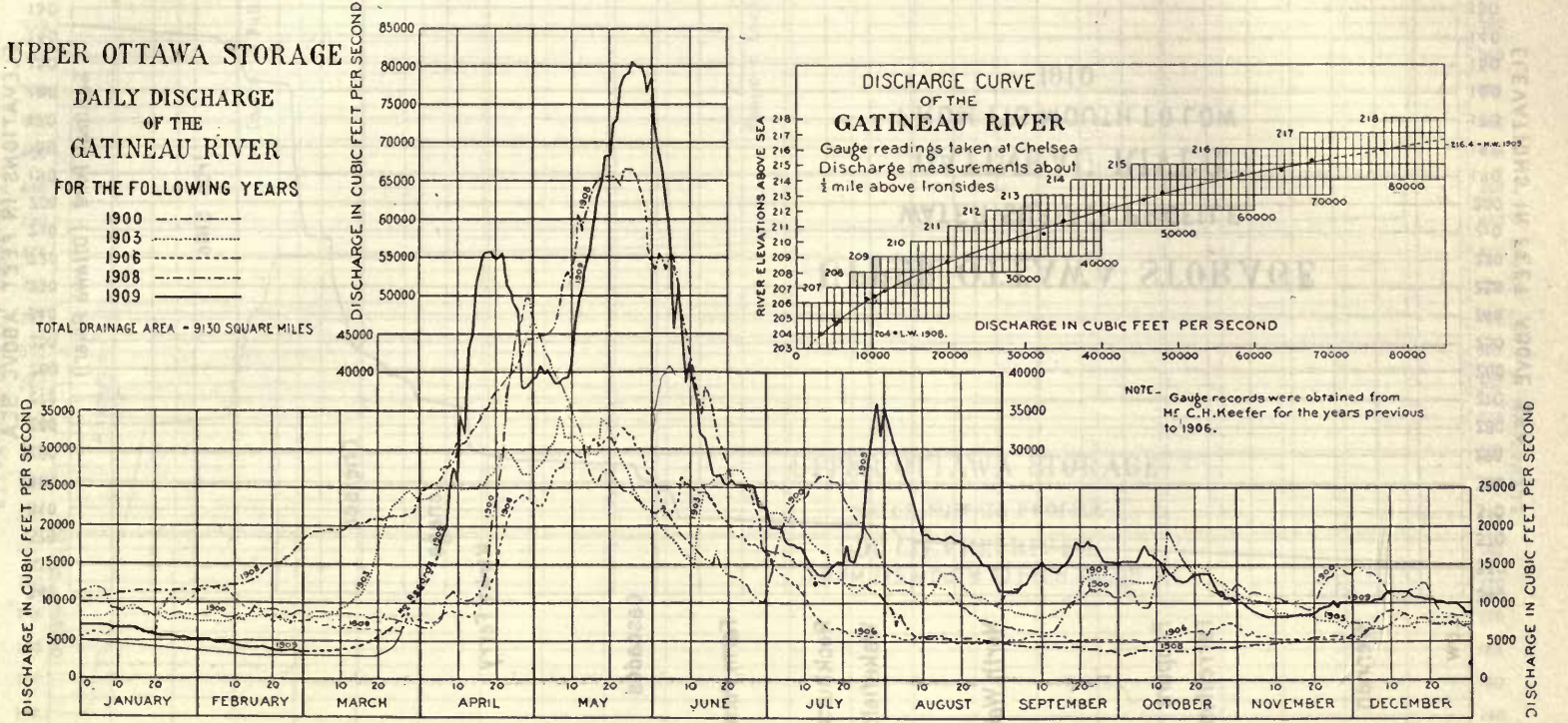
UPPER OTTAWA STORAGE

DAILY DISCHARGE OF THE GATINEAU RIVER

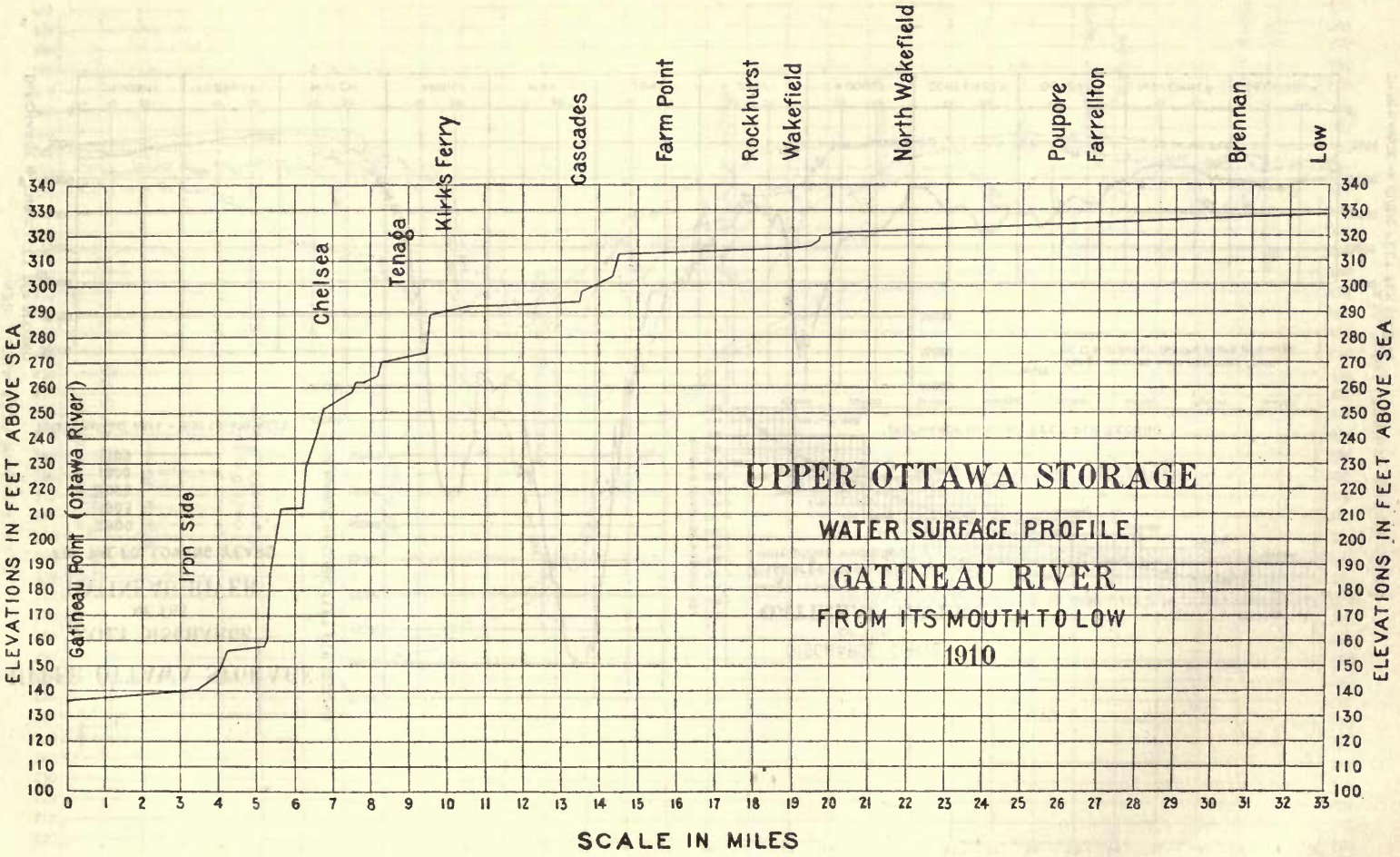
FOR THE FOLLOWING YEARS

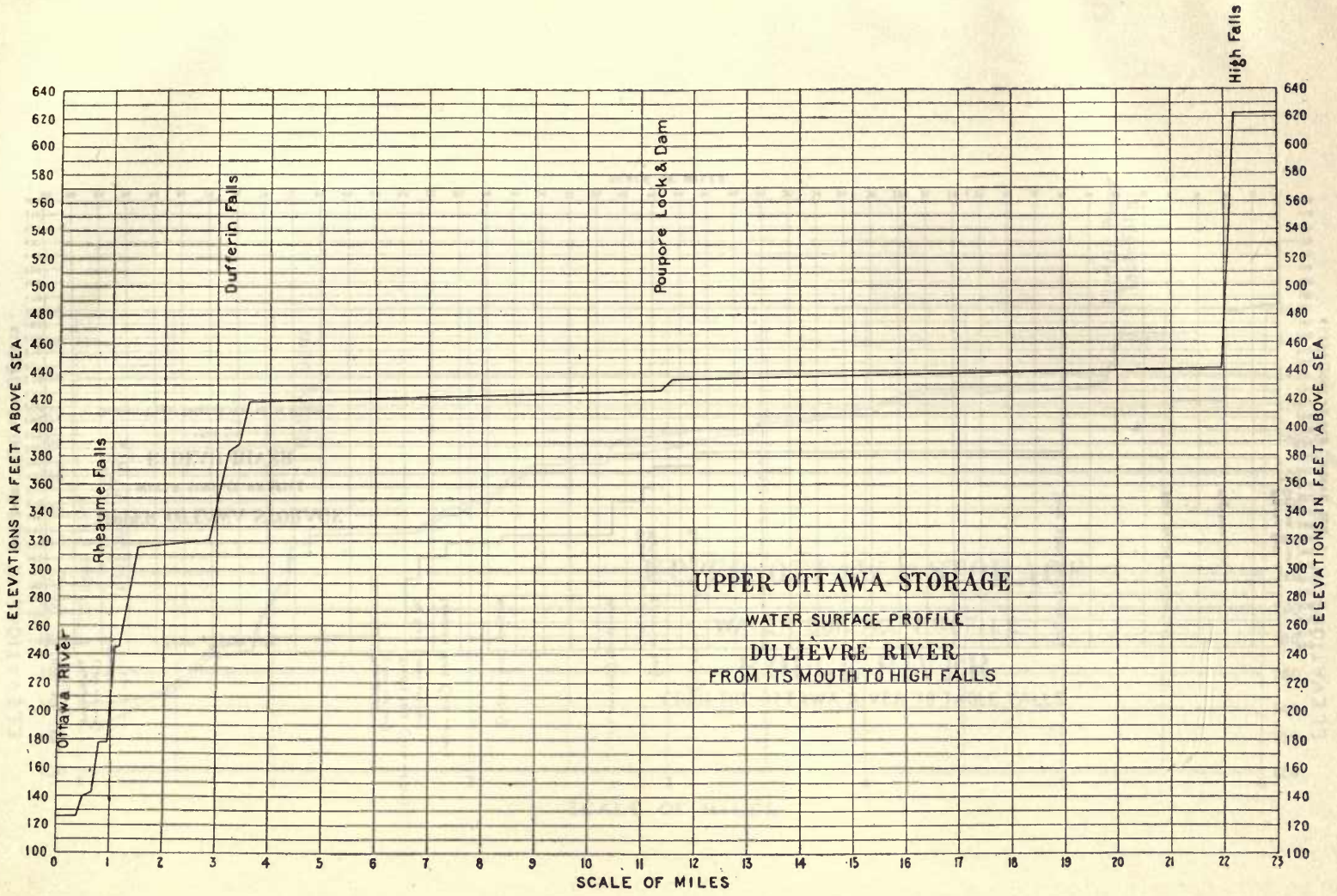
1900
1903
1906
1908
1909

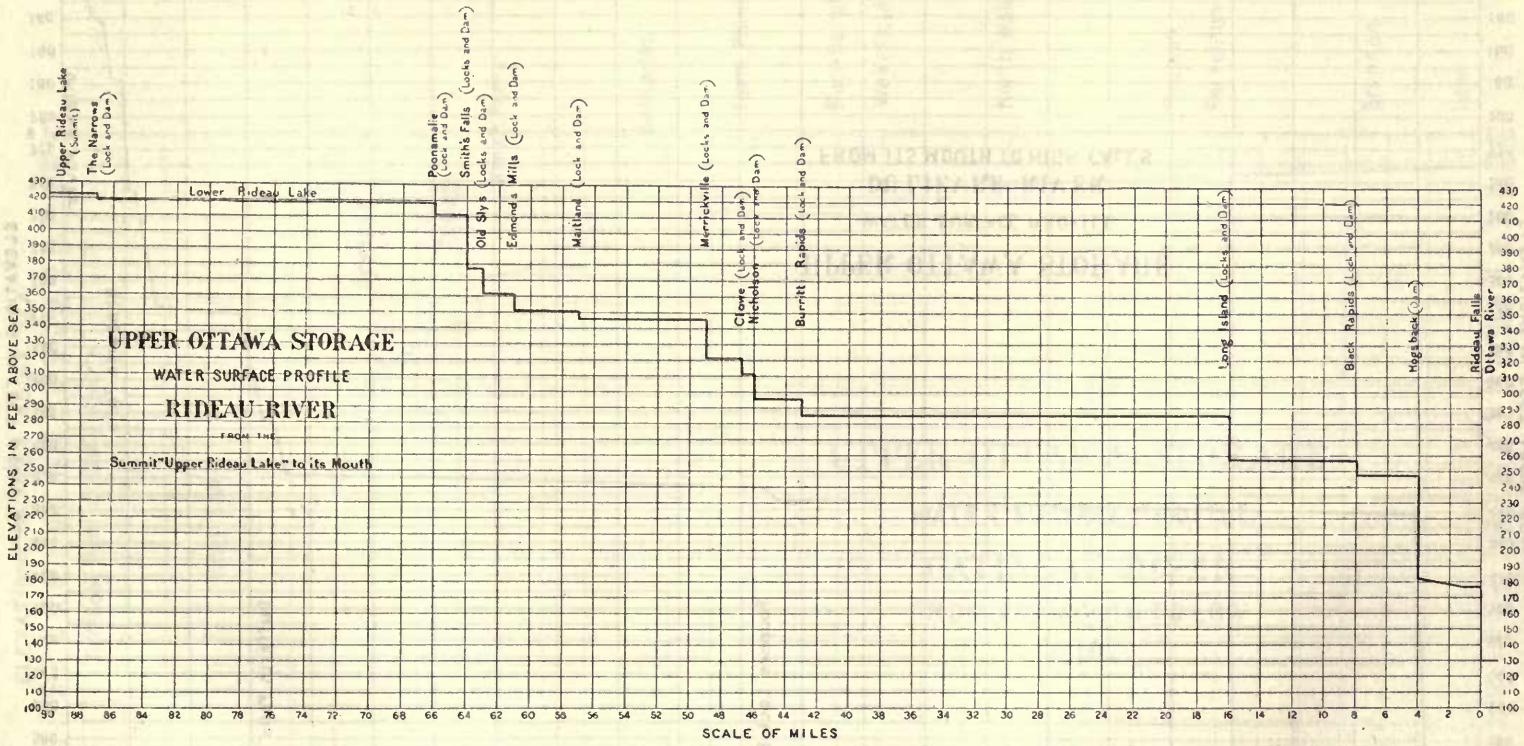
TOTAL DRAINAGE AREA = 9130 SQUARE MILES

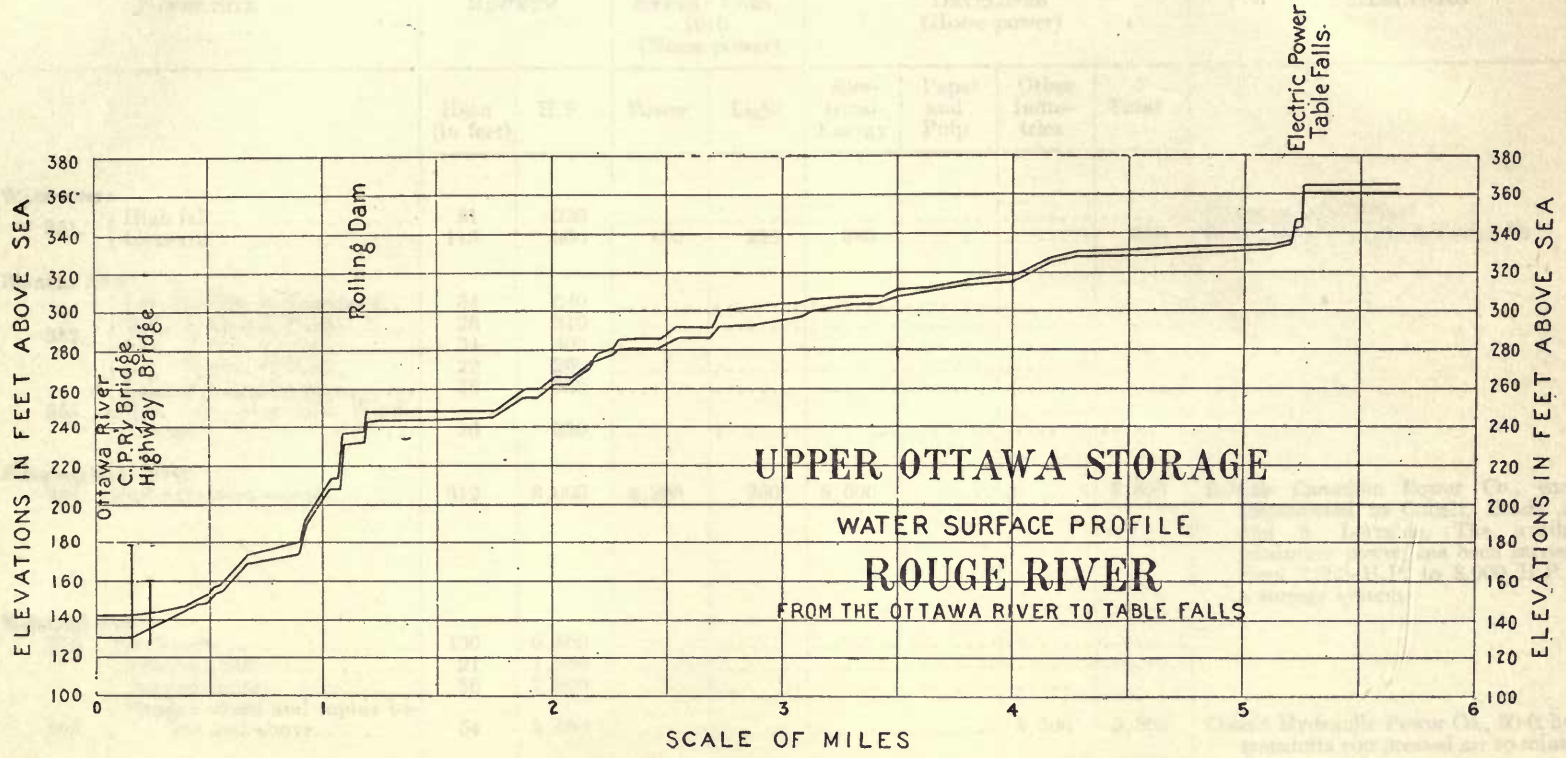


NOTE- Gauge records were obtained from Mr. C.H. Keefer for the years previous to 1906.


Gatineau Point (Ottawa River)
Iron Side
Chelsea
Tenaga
Kirk's Ferry
Cascades
Farm Point
Rockhurst
Wakefield
North Wakefield
Poupore
Farrellton
Brennan
Low
ELEVATIONS IN FEET ABOVE SEA
SCALE IN MILES
UPPER OTTAWA STORAGE
WATER SURFACE PROFILE
GATINEAU RIVER
FROM ITS MOUTH TO LOW
1910


High Falls
Dufferin Falls
Poupore Lock & Dam
Rheaume Falls
Ottawa River
ELEVATIONS IN FEET ABOVE SEA
ELEVATIONS IN FEET ABOVE SEA
640 620 600 580 560 540 520 500 480 460 440 420 400 380 360 340 320 300 280 260 240 220 200 180 160 140 120 100
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
SCALE OF MILES
UPPER OTTAWA STORAGE
WATER SURFACE PROFILE
DU LIÈVRE RIVER
FROM ITS MOUTH TO HIGH FALLS


Upper Rideau Lake (Summit)
The Narrows (Lock and Dam)
Lower Rideau Lake
Poonamalie (Lock and Dam)
Smith's Falls (Locks and Dam)
Old Slys (Locks and Dam)
Edmonds
Mills (Lock and Dam)
Maitland (Lock and Dam)
Merrickville (Locks and Dam)
Clowe (Lock and Dam)
Nicholson (Lock and Dam)
Burritt Rapids (Lock and Dam)
Long Island (Locks and Dam)
Black Rapids (Lock and Dam)
Hogsback (Dam)
Rideau Falls
Ottawa River
UPPER OTTAWA STORAGE
WATER SURFACE PROFILE
RIDEAU RIVER
FROM THE
Summit "Upper Rideau Lake" to its Mouth
ELEVATIONS IN FEET ABOVE SEA
SCALE OF MILES


Electric Power
Table Falls.
Rolling Dam
Ottawa River
C.P.R. Bridge
Highway Bridge
UPPER OTTAWA STORAGE
WATER SURFACE PROFILE
ROUGE RIVER
FROM THE OTTAWA RIVER TO TABLE FALLS
ELEVATIONS IN FEET ABOVE SEA
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
0
1
2
3
4
5
6
SCALE OF MILES

SCALE OF MILES

DISTRICT No. X.—TRIBUTARIES OF THE OTTAWA RIVER

Power Site	Minimum		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				REMARKS
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
Wabi river:									
351. High fall	81	220	.....	.....	.....	.....	.....	.....	Nipissing Central Ry.
351. Liskeard	113	300	130	250	380	.....	.....	380	New Liskeard Light & Power Co.
Blanche river:									
352. Lot, 12, Con. 3, Evanturel	54	640	.....	.....	.....	.....	.....	.....	
352. Lot, 1, Con. 3, Dack	26	310	.....	.....	.....	.....	.....	.....	
352. Lot, 2, Con. 4, Dack	34	400	.....	.....	.....	.....	.....	.....	
352. Lot 7, Con. 4, Dack	22	260	.....	.....	.....	.....	.....	.....	
353. Lake Windigo branch	36	330	.....	.....	.....	.....	.....	.....	
353. One mile below lake Windigo	36	330	.....	.....	.....	.....	.....	.....	
Matabetchuan river:									
354. Half-mile from mouth	312	8,000	4,300	260	8,600	.....	.....	8,600	British Canadian Power Co., energy transmitted to Cobalt, Brady lake and S. Lorraine. The available minimum power has been increased from 2,000 H.P. to 8,000 H.P. by a storage system
Montreal river:									
355. The Notch	100	6,500	.....	.....	.....	.....	.....	.....	
356. Fountain fall	21	1,350	.....	.....	.....	.....	.....	.....	
356. Ragged chute	36	2,360	.....	.....	.....	.....	.....	.....	
356. Ragged chute and rapids below and above	54	3,500	.....	.....	.....	.....	5,500	5,500	Cobalt Hydraulic Power Co., 50 ft head; transmits compressed air to mines in Cobalt region
356. Hound chute	18	1,180	1,500	150	3,600	.....	.....	3,600	Cobalt Power Co., 33.4 ft. head; current transmitted to Cobalt, with taps along line to supply outlying mines

DISTRICT No. X.—TRIBUTARIES OF THE OTTAWA RIVER—*Continued*

Power Site	Minimum		Electrical Energy Used, 1910 (Horse-Power)		Developed (Horse-Power)				REMARKS
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
357. Latchford rapid	8	510	.....	.....	.....	.....	.....	.....	
358. Mattawapika rapid	30	270	.....	.....	.....	.....	.....	.....	
Mattawa river:									
359. Plein Chant rapid and chute	17	250	17	108	125	.....	.....	125	Electric light plant
360. Paresseux chute	33	360	.....	.....	.....	.....	.....	.....	
360. Little Paresseux rapid	8	95	.....	.....	.....	.....	.....	.....	
360. Talon chute	42	230	.....	.....	.....	.....	.....	.....	
Petawawa river:									
361. 1st series of rapids below Catfish lake	119	1,290	.....	.....	.....	.....	.....	.....	
361. 2nd series of rapids below Catfish lake	41	445	.....	.....	.....	.....	.....	.....	
361. 3rd series of rapids below Catfish lake	80	875	.....	.....	.....	.....	.....	.....	
362. 1st series of rapids below Cedar lake	29	390	.....	.....	.....	.....	.....	.....	
362. 2nd series of rapids below Cedar lake	33	435	.....	.....	.....	.....	.....	.....	
362. 3rd series of rapids below Cedar lake	36	475	.....	.....	.....	.....	.....	.....	
363. 1st series of rapids below Little Trout lake	18	310	.....	.....	.....	.....	.....	.....	
363. 2nd series of rapids below Little Trout lake	13	225	.....	.....	.....	.....	.....	.....	
363. Laveille creek	31	170	.....	.....	.....	.....	.....	.....	

364.	2nd series of rapids below Laveille creek	25	570							
	3rd series of rapids below Laveille creek	16	370							
	4th series of rapids below Laveille creek	27	630							
	5th series of rapids below Laveille creek	24	560							
	6th series of rapids below Laveille creek	44	1,000							
365.	1st series of rapids below lake Travers	16	410							
	3rd series of rapids below lake Travers (Crooked chute)	41	1,050							
366.	1st rapid above South branch	13	330							
	1st rapid below South branch	13	445							
	2nd rapid below South branch	18	615							
	At C. P. Ry. bridge	21	725							
	2nd rapid above mouth	24	830							
	1st rapid above mouth	21	725							
Gould creek:										
367.	Cobden	48			50	50			50	Electric plant; uses steam auxiliary
Muskrat river:										
368.	Pembroke	12	65					75	75	Grist mill
Indian river:										
368	Pembroke	9	25							Foster's mill
Bonnechère river:										
369.	Rabital cascades	405	730							
	High fall	30	55							
370.	Eganville	14	135					300	300	Lumber mill
	"							120	120	Flour mill and electric plant
	"							40	40	Sash factory
	"	12	115					300	300	Flour mill and electric plant
	"	12	115							
371.	Fourth chute	46	460							Possible development
	" "	15						700	700	Lumber mill
	Third chute	21	210							

DISTRICT No. X.—TRIBUTARIES OF THE OTTAWA RIVER—*Continued*

Power Site	Minimum		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				REMARKS
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
372. Renfrew	27	350			500			500	Renfrew Power Co.
"	20	255					100	100	Woollen mills
"							110	110	Lumber mill and electric plant
"							300	300	Renfrew Milling Co.
"							50	50	Thomas Lowe
"					1,000			1,000	Municipal electric plant; uses steam auxiliary
"	36	450							
"							300	300	Town waterworks
Smith creek (tributary)	44	60					190	190	Sash factory
First chute	32	420							
York river:									
373. Bancroft	16						150	150	Grist and woollen mills
Constaw creek:									
374. Dacre	11						60	60	Lumber mill
White Lake creek:									
375. Waha	15						150	150	Lumber mill
Madawaska river:									
376. Palmer rapid	17	980							
Aumond rapid	7	410							
Snake rapid	30	1,820							
Slate fall	23	1,510							

377.	Highland chute	12	790							
	Camel chute and rapid	19	1,280							Lumber mill; 8 ft. head
	Cotton chute	18	1,230							
	Rapids	13	885							
378.	Deschênes rapid and rapids above	29	2,030							
	Rapids	7	490							
	Cedar rapid	31	2,180							
	Mountain chute	40	2,860	500	50	550			550	Electric plant for graphite mine; 20 ft. head
379.	Norway chute	8	575							
	Chain rapid	15	1,100							
	The Ducks	16	1,220							
380.	Ragged chute	16	1,220							
	High fall	78	5,960							
	Barret chute	17	1,300							
381.	Calabogie rapid	20	1,560							
382.	Sixteen miles of rapids, Arnprior	20	1,610							Present dam dilapidated
	"	18						200	200	Grist mill
	"	9						75	75	Machine shop
	"	9			75	75			75	Electric light plant
	"	10						300	300	Saw mill
Clyde river:										
383.	Herron rapid	15						40	40	Grist and lumber mills
	Lanark rapid	14						50	50	Grist mill
Mississippi river:										
384.	King rapid	24	305							
	Otter rapid	15	190							
	Island rapid	38	485							
	Ragged rapid	38	485							
	High fall	72	915							
385.	Geddes Bros.	15	130							Grist mill
	Playfairville	15	200							Lumber mill
386.	Innisville	13	275							

DISTRICT No. X.—TRIBUTARIES OF THE OTTAWA RIVER—*Continued*

	Power Site	Minimum		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				Remarks
		Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
	Carleton Place	12	272							Possible development
	" "	8			200	200		250	450	Electric light stations and flour mill
	" "	8	182							Possible development
387.	" "	7						70	70	Engines
	" "	7						200	200	Woollen mills
	Appleton	16	360					100	100	" "
	Almonte	10	270					100	100	Flour mill
	"							40	40	Flannel mill
	"							30	30	Machine shop
	"	51	1,390					500	500	Woollen mills
388.	"	24			190	300			300	Municipal electric plant
	"	22						190	190	Dress goods, etc.
	"	18						75	75	Woollen goods
	"	14						150	150	Shoddy mill
	"	7						100	100	Knitting mill
	Rosebank	23	670							Woollen mill
389.	"									Grist mill
	Pakenham	18	540							Flour mill
								35	35	Woollen mill
390.	Galetta	25	780	40	175	1,800			1,800	Galetta Electric Power Co., 28 ft. head; supplies energy to Arnprior
								80	80	Grist mill privilege
Rideau river:										
	Westport	20			80	80			80	Westport Electric Light & M. Co.
391.	"	8						25	25	Lumber mill

	Smiths Falls	6	76					280	280	
	" "							90	90	Plough works
	" "	18	230					100	100	Woollen mills
392.	" "	17						300	300	Stove works
	" "	17						500	500	Flour and planing mills
	" "	15						800	800	Flour mill
	" "	12						400	400	Municipal pumping
	One mile below Smiths Falls	18	230	100	275	750			750	Smiths Falls Electric Co.
	Merrickville	26	505							Possible development
	"	12	235		120	120			120	Electric light plant
	"							100	100	Lumber mill
	"							70	70	Malleable iron works
	"							170	170	Flour mill
393.	"							50	50	Woollen mill
	"							50	50	Ploughs and stoves
	"							120	120	Grist and saw mills
	"							80	80	Furniture
	Andrewsville	13	220	100	200	300			300	Kemptville electric supply
394.	Manotick	10	330					750	750	Grist mills
	Black rapid	10	330							
395.	Hogsback rapid	50	1,820							
	Ottawa, Rideau falls	45	1,640					4,000	4,000	Lumber mill
Tay river:										
	Near Perth (3 miles)	16	80	125	100	275			275	Canadian Electric & Water Power Co: electricity for Perth; have steam auxiliary
396.										
	" " (4 miles)	12	50		50	50			50	Perth municipal electric plant
Devil Lake creek:										
397.	Bedford Mills	13						145	145	Lumber and grist mills

ONTARIO AND QUEBEC

DISTRICT No. XA.—OTTAWA RIVER POWERS, BETWEEN THE MOUTH AND LAKE TIMISKAMING

Power Site	Minimum		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				REMARKS
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
Ottawa river:*									
398. Riv. des Prairies	22	46,000[b]	.....	.....	.....	.....	.....	.....	Practically no power available under present conditions
399. At proposed Recollet lock	10	.....	.....	.....	.....	400	175	575	Head reduced considerably at high water; Mr. C. E. Gauvin gives 23,727 H.P. under present conditions
	35	23,000[b]	.....	.....	.....	.....	.....	.....	
400. Riv. Jesus at Terrebonne	10	.....	.....	200	200	.....	.....	200	Total power not estimated; electrical energy supplied to Terrebonne, pop. 2,000
401. Carillon rapid	13.5	26,000[a]	.....	.....	.....	.....	.....	.....	
	40	200,000[b]	.....	.....	.....	.....	.....	.....	

*For a detailed discussion on the regulation and storage possibilities of the Ottawa river and its tributaries, including data upon the drainage areas of the various sections of the river, gaugings, discharges, etc., consult *Report Georgian Bay Ship Canal*, 1908, pp. 240 *et seq.* For *Map of Ottawa River Watershed*, see *Ibid*, Plate 111. For more recent and extensive data respecting the storage possibilities of the waters of the upper Ottawa river basin, consult *Ottawa River Storage, Progress Report*, (fiscal year 1909-1910), *Sessional Papers*, Canada, No. 19a—1911. Also, consult *Bibliography*, in Appendix.

a Shows possible development under present conditions.

b Shows development with regulated water and canalized river.

402.	Long Sault	12	23,000[a]	.....	.....	.....	.....	2,000	2,000	Used for lumber mill; Hawkesbury Lumber Co.
		19	94,000[b]	.....	.....	.....	.....	.....	.....	
403.	Chaudière fall	30	50,000[a]	6,200	7,800	14,000	23,000	18,500	55,500	Electrical energy supplied to Ottawa, Hull and suburbs: total pop. 100,000
		30	95,000[b]	.....	.....	.....	.....	.....	.....	"Other industries" include lumber mill and waterworks
404.	Deschênes and Britannia rapids	8.5	14,000[a]	2,000	1,000	3,000	.....	.....	3,000	
		20	63,000[b]	.....	.....	.....	.....	.....	.....	
405.	Chats falls	48	58,000[a]	.....	.....	.....	.....	.....	.....	
		48.5	150,000[b]	.....	.....	.....	.....	.....	.....	
406.	Chenaux rapid	35	91,000[b]	.....	.....	.....	.....	.....	.....	
407.	Portage-du-Fort rapid	9	400	.....	.....	.....	.....	.....	.....	This power is in the Portage-du-Fort channel on the Quebec side, but most of the water flows on the Ontario side
408.	Grand Calumet fall and rapids	56	30,000[a]	.....	.....	.....	.....	.....	.....	Mr. C. E. Gauvin subdivides the "Grand Calumet" into the following falls which are all on the Quebec side: (a) Sable rapids (confluence of Calumet and Rocher Fendu channels, 4.2 ft. fall, 3,800 H.P. (b) Mountain rapid, 15 ft. fall, (c) Dargis rapid, 6 ft. fall, } 19,000 H.P. (d) Grand Calumet fall, 57 ft. fall 50,000 H.P.
		69	76,000[b]							

a Shows possible development under present conditions.
b Shows development with regulated water and canalized river.

	Power Site	Minimum		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				REMARKS
		Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
409.	Rocher Fendu No. I.	47	26,000[a]							Mr. C. E. Gauvin gives the following data respecting the falls and rapids of the Rocher Fendu channel:—In Quebec: (a) Garvin chute, 10.5 ft. fall, 5,000 H.P. (b) Timber slide, 12 ft. fall, 1,400 H.P. (c) Desjardins' rapid, 9 ft. fall, 3,000 H.P. In Ontario and Quebec: (a) Rocher Fendu chute, 5.5 ft. fall, 5,600 H.P. (b) Long rapid, 16 ft. fall, 16,000 H.P. (c) Muskrat rapid, 7 ft. fall, 7,000 H.P. (d) Mice rapid, 3.2 ft. fall, 3,200 H.P (e) Crawford rapid, 20 ft. fall, 7,000 H.P. (f) Black fall, 10 ft. fall, 5,700 H.P.
		35	51,000[b]							
	Rocher Fendu No. 2.	35	19,000[a]							
		35	51,000[b]							
410.	Paquette and Allumette rapids	16	12,000[a]							
		20	34,000[b]							
411.	Culbute rapid	20	6,000[b]							
	L'Islet rapid	14	2,000[a]							

a Shows possible development under present conditions.
b Shows development with regulated water and canalized river.

412.	Des Joachims rapid	35	31,200[a]	.....	.....	.....	.....	.....	.....	
		40	80,800[b]	.....	.....	.....	.....	.....	.....	
413.	Rocher Capitaine rapid	59	50,000[a]	.....	.....	.....	.....	.....	.....	
		59	108,000[b]	.....	.....	.....	.....	.....	.....	
414.	Deux Rivières rapid	15	13,000[a]	.....	.....	.....	.....	.....	.....	
		30	54,000[b]	.....	.....	.....	.....	.....	.....	
415.	Johnson and Mattawa rapids	8	7,000[a]	.....	.....	.....	.....	.....	.....	
416.	Cave rapid	9.2	8,300[a]	.....	.....	.....	.....	.....	.....	
	Les Erables rapid	13	11,300[a]	.....	.....	.....	.....	.....	.....	"Les Erables" and "Cave" could be combined, giving a total of 20,000 H.P.
417.	Long Sault rapids	56	41,362[a]	.....	.....	.....	.....	.....	.....	These rapids extend from Seven League lake to lake Timiskaming (6 miles) and include: (a) First rapid, 10 ft. fall, 7,386 H.P. (b) Fourneau rapid, 11 ft. fall, 8,124 H.P. (c) Crooked rapid, 12 ft. fall, 8,864 H.P. (d) Flat rapid, 16 ft. fall, 11,818 H.P (e) Foot of lake Timiskaming, 7 ft. fall, 5,170 H.P.

[a] Shows possible development under present conditions.
[b] Shows possible development with regulated water and canalized river.

CHAPTER IV

The Water-Powers of Quebec

THE important part which water-powers have played in the industrial development of the province of Quebec may be realized from a recent estimate of the different kinds of power utilized. This elicited the information that over eighty per cent. of the total power used in the Province was water-power. The local government, becoming aware of the importance of this natural resource, has of late devoted a good deal of attention to gauging the streams of the Province and investigating their power possibilities. Since 1897 the reports of the Department of Lands, Forests and Mines contain much useful data respecting many of the water-powers of the Province, more attention being paid to the undeveloped sites for which applications for purchase have been made to the Government. As may be gathered from the tables of water-powers which follow, the wood-pulp and paper industry has contributed a great deal to the development of this kind of energy; but other industries have also taken advantage of it, such as lumber mills, textile mills and rubber factories. By the use of electrical energy as a transmission medium, the benefits of water-powers have been extended to the important asbestos mining region, to electro-chemical works, and to cement works; and, it may be further stated, that all the important centres of population of the Province have been, for a number of years, supplied with electrical energy generated by water-power, one of them, Three Rivers, claiming the first long distance transmission line in existence in the British Empire.

Disposal of Water-Powers

The regulations* under which water-powers have been disposed of in Quebec are summed up in a "Return" to the Legislative Assembly, Feb. 28, 1907. It also contains a detailed statement of all sales, leases or grants of water-powers made by the Province, between June 30th, 1867 and January 1st, 1907. The powers were referred to four periods, as follows:

FIRST PERIOD: JULY, 1867, TO MAY, 1897.—During this period,

* "There is no Act or printed Regulations in this Province laying down rules for the disposal of water-powers. Within the last few years, however, it has been the custom to grant rights to develop and utilize falls, under emphyteutic leases, for periods varying between 75 and 99 years. The grantee is requested to pay to the Crown an annual royalty proportionate to the importance of the power, and to further make a deposit sufficient to guarantee said payments. He is, moreover, under obligation to begin works and supply power at certain fixed dates. Failing to do this, his deposit may be forfeited and the power is returned to the Crown."—(*Letter from E. E. Taché, Deputy Minister of Lands and Forests, Quebec, March 28th, 1911.*)

OUIATCHUAN FALLS, LAKE ST. JOHN, QUEBEC

water-powers were sold without special conditions, and were considered as forming part of the adjacent lots sold as mill-sites, with which they were conceded.

SECOND PERIOD: MAY 30, 1897, TO JUNE 30, 1904.—The return contains a list of some forty-eight water-powers. In all cases these powers were sold outright, although there were instances where certain conditions had to be fulfilled, such as developing a certain horse-power or expending a certain amount within a fixed time. Many of these sales were for sites which had been occupied for a long time by the ultimate purchasers, who had probably acquired their rights as under the First Period, the sale being, apparently, made to quiet the title.

THIRD PERIOD: JULY 1, 1904, TO JUNE 30, 1906.—Includes eight water-powers which were sold and three which were leased for ninety-nine years, the purchaser or lessee having to fulfil conditions similar to those stipulated for the Second Period.

FOURTH PERIOD: JULY 1, 1906, TO JAN. 1, 1907.—In this period eight water-powers were sold without any special obligation on the part of the purchaser regarding development or expenditure within a stated time.

From January 1st, 1907, the disposal of water-powers, as given each year in the Report of the Department of Lands and Forests, may be summarized as follows:

Jan. 1st, 1907 to June 30, 1907: Seven water-powers sold. No special obligations regarding development mentioned.

June 30, 1907, to July 1, 1908: Seven water-powers sold and one leased for ninety-nine years. No special obligations regarding development mentioned.

July 1, 1908, to June 30, 1909: Three water-powers sold. No special conditions mentioned.

In the report covering this period, there is also shown an offer to lease two large water-powers on the Quinze river for a period of seventy-five years, with certain conditions regarding the amount to be expended on development.

Since June 30th, 1909, two water-powers were sold outright and one leased for ninety-nine years, the latter being the Cedars rapid on the St. Lawrence river.

Statutory Enactments

The provincial statutes deal more particularly with the the rights of the owners or lessees of water-powers than with the manner in which the powers are to be disposed of by the Government. The following is a summary of the different articles of the Revised Statutes, 1910, pertaining to water-powers:

MINING LOCATIONS.—Owners of mining locations bounded by rivers may use said rivers for their work, provided they do not hinder one another or change the courses of the rivers to the detriment of riparian owners farther down the stream. (Arts. 2160 and 2175.)

EXPROPRIATION RIGHTS.—After plans prepared by a Quebec land surveyor have been submitted, and after approval has been given by Lieutenant-Governor in Council, the proprietor of a water-power of at least 200 gross H.P., may proceed to expropriate immovable properties and riparian rights necessary to utilize such water-power, provided industries or water-works already established are not interfered with. The expropriation proceedings and the indemnity are to be subject to the provincial law relating to railways, and the expropriating party shall not take possession of the property until after the award of the arbitrators is rendered and the indemnity paid. (Arts. 7287 to 7294.)

A riparian proprietor may improve any stream bordering on or passing through his property and may utilize the same by the construction of mills, flumes, dams or other works. The proprietors or lessees of such works, however, are held responsible for damages caused by their construction; such damages to be ascertained by experts or arbitrators. If damages are not paid, the works are to be destroyed. This does not apply to dams, booms and fallen trees, unless the flow of the water or the passing of rafts be impeded. (Arts. 7295 to 7297.)

TIMBER DRIVING COMPANIES.—A company formed to construct and maintain works to facilitate the transmission of timber in streams, has no right to any water-power created by any of said works. (Arts. 6315 to 6319.)

Acts of Incorporation

A good idea of privileges granted by the Government regarding water-powers may be formed by considering some of the Acts of Incorporation granted to companies from time to time. The following is a summary of a number of these:

ACT TO INCORPORATE CHAMBLY HYDRAULIC & MFG. CO.—The Company is given the right to construct and maintain a dam across the Richelieu river near "Yule bridge" and to conduct water therefrom by canals; while it may also acquire necessary lands, and sell water-power. These privileges shall be forfeited by non-user during three consecutive years.*

ACT TO INCORPORATE SHERBROOKE WATER-POWER CO.—The Company was given the right to acquire lands, construct dams and canals within their own lands, and were permitted to erect factories and sheds, which they might occupy, sell or lease.†

* Quebec Statutes, 1868, chap. 46.
† Quebec Statutes, 1870, chap. 42.

SHAWINIGAN FALLS, ST. MAURICE, QUEBEC

AN ACT TO INCORPORATE THE CANADIAN ELECTRIC LIGHT CO.—The Company was given the right, after acquiring necessary lands and property, to use hydraulic power, erect and maintain dams across rapids of any river, divert water through canals or flumes and sell surplus water. The Act also states that the Company has no rights under Federal jurisdiction without previous sanction of the Dominion Government.*

AN ACT TO INCORPORATE THE HYDRAULIC & MFG. CO. OF ST. JOHNS AND IBERVILLE.—The Company was granted the right to dredge the Richelieu river between Jones' bridge and St. Thérèse mill; to construct a moveable dyke or dam at the head of the rapids between the towns of St. Johns and Iberville, the dam to open completely when the water was high, to avoid floods. Further, the Company was to have the right to acquire and utilize all water-powers on each side of the rapids, and to use, sell, transfer or lease any or all said water-powers. The Company could not, however, construct a dyke across the Richelieu river, nor do anything to affect navigation without the consent of the Parliament of Canada.†

AN ACT TO INCORPORATE THE COATICOOK RIVER WATER-POWER CO. —The Company was authorized to construct and maintain reservoirs at the head-waters of the Coaticook river and improve the water-power in said river. Tolls for the use of water-power may be levied.‡

ACT TO INCORPORATE THE SHAWINIGAN WATER AND POWER COMPANY.—By the terms of the Act, the Company was given the right to erect and maintain dams on the north-west bank of the St. Maurice river, near Shawinigan falls, to take water through canals or flumes for hydraulic and manufacturing purposes, to construct the necessary locks, piers and power houses, to take possession of the bed and the beach of the river at the entrance of canals and flumes and at the outlets of water from the canals or tail races. The Company was permitted to use, sell or lease the water coming from the flumes to drive machinery. It was granted the further right to manufacture, supply and sell gas, electricity and carbide. The right was also given to enter upon land for surveys on the line of the rapids, and to purchase lands along the sides of the flumes.**

AN ACT TO INCORPORATE THE RIVIÈRE DU NORD WATER-POWER CO.—The preamble of this Act sets forth what rights the Company desired to obtain, and also points out that the deforestation of the lands on the Rivière du Nord and its tributaries had caused a decreased flow in the river, and endangered the various industries along its course. The Company was given the right to purchase, lease and operate water-

* Quebec Statutes, 1881, chap. 69.
† Quebec Statutes, 1887, chap. 48.
‡ Quebec Statutes, 1890, 54 Vict., chap. 73.
** Quebec Statutes, 1898, chap. 70.

powers on the above-named river and its tributaries; to purchase, construct and use dams, canals and other improvements on the said river and on its tributaries and lakes, for the purpose of storing water and for the purpose of regulating the flow according to the needs of the water-power users. It was permitted to charge tolls for the use of its works, the tariff to be fixed by the Lieutenant-Governor in Council.*

List of Principal Water-Powers

For purposes of reference, the Province has been divided geographically into ten districts, as follows:

(1) Ottawa river tributaries.
(2) North shore of the St. Lawrence between the Ottawa and St. Maurice rivers.
(3) St. Maurice river and tributaries.
(4) North shore of St. Lawrence, between the St. Maurice and Saguenay rivers.
(5) Saguenay river and tributaries.
(6) North shore of St. Lawrence, below the Saguenay and Hamilton River basin.
(7) South shore of St. Lawrence, below River du Loup.
(8) South shore of St. Lawrence, between River du Loup and the Chaudière river (incl.).
(9) South shore of St. Lawrence above Chaudière river, including St. Lawrence above Montreal.
(10) James Bay slope.

In the list which follows, the water-powers have been classified under the different districts above mentioned and grouped under the different rivers on which they are situated. As most of the water-powers on the Ottawa river, below Quinze river are common to the provinces of Ontario and Quebec, they are not included in this list, but are given separately on page 144.

The list has been divided into two general divisions:

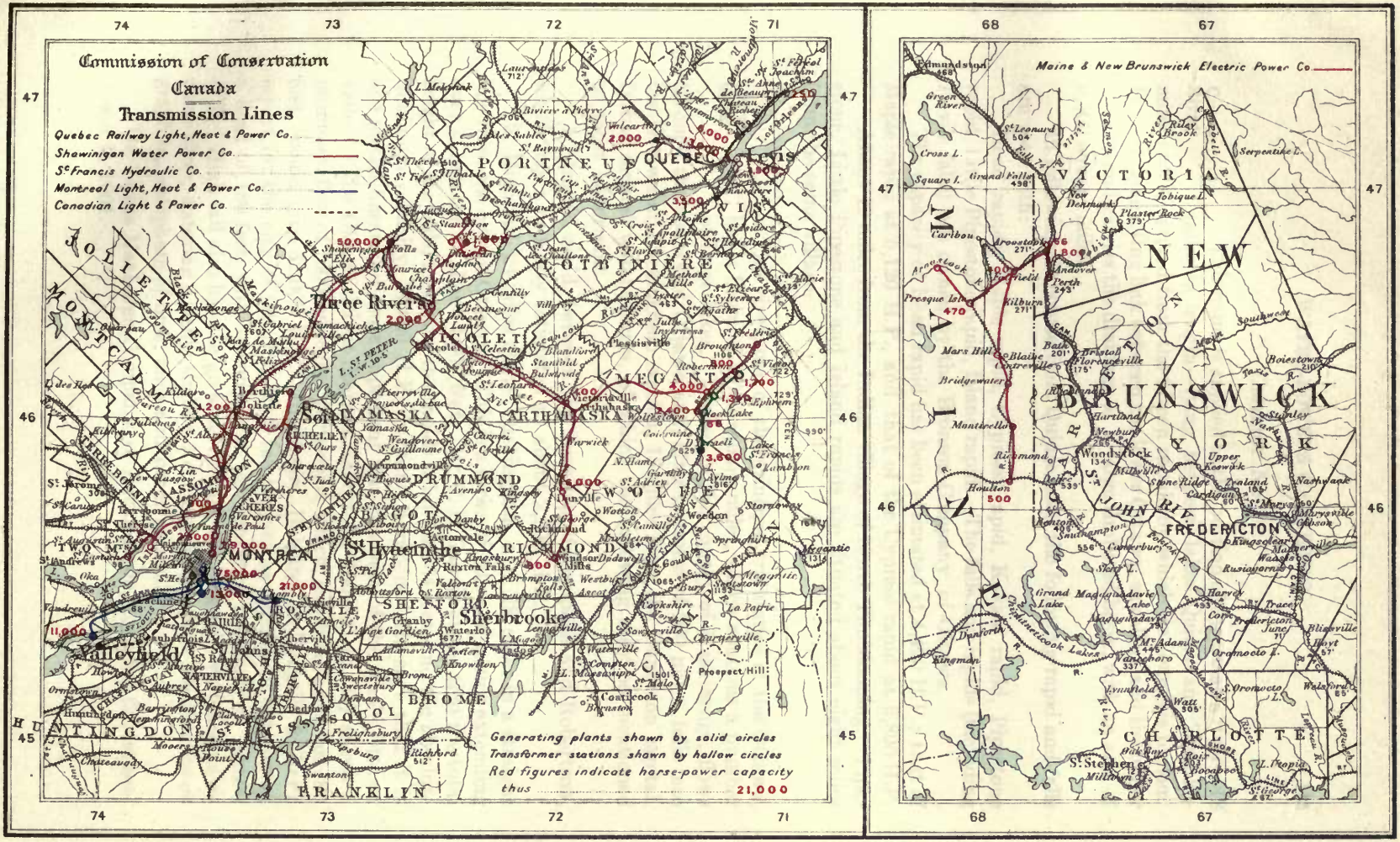
(a) Water-powers on which fairly accurate information was obtainable.

(b) Water-powers on which only approximate figures were obtainable. Some of the districts, viz: V, VI and VII include water-powers of both classes. For District No. X, only approximate data were obtainable.

Notes on Power Possibilities of Principal Rivers

A general idea of the main water-power characteristics of the more important rivers mentioned in the foregoing tables is given below:

* Quebec Statutes, 1908, chap. 115.



TRANSMISSION LINES IN QUEBEC AND NEW BRUNSWICK

District No. I.

Quinze River

This name is applied to the portion of the Ottawa river—18 miles in length—lying between lakes Quinze and Timiskaming and is derived from the fifteen rapids by which its course is broken. It is the connecting link between the lower Ottawa, so called, and the upper Ottawa and carries the drainage of a large timbered basin, with an area of 9,500 square miles.

In following its course from Quinze lake, the following rapid and falls are met with:

Head rapids, Maple rapid, Cypress rapid, Kakaki rapid, Pipestone rapid, Little Pipestone rapid, Island rapid. The falls and rapids (including Devils falls) are owned by the Bronson Company, of Ottawa.

The capacity of Head rapid has been estimated at 4,420 H.P.; that of Maple rapid at 6,120 H.P., and that of the Cypress rapid at 6,800 H.P.

About 12 miles from the Indian village of North Timiskaming. Pipestone, Little Pipestone and Island rapids are situated about eight miles from the same village.

Lièvre River

This river, one of the principal tributaries of the Ottawa, has a basin of 4,000 square miles, which contains a number of large lakes. It rises in the county of Maskinonge, flows through the county of Ottawa and, after a course of 200 miles, falls into the Ottawa at Buckingham station, 15 miles from the Dominion capital. It has several water-powers, of which the following may be mentioned as most important:

1. Orignal rapid, between the township of Campbell and Robertson, which has a capacity estimated at about 2,200 H.P.

2. High fall, 24 miles above Buckingham, and 28 miles in a straight line from the city of Ottawa. This is a series of falls and rapids extending over a distance of about 4,000 feet. Mr. C. E. Gauvin states that the total height of the falls, including the rapids below, is 154 feet, and the absolute minimum capacity, 34,600 H.P. in round numbers. He says that it is one of the finest and most important water-powers of the whole Ottawa valley. The Ottawa River Storage Report for 1909-10 (p. 63) shows a minimum flow of 1500 cubic feet per second, which, assuming a head of 180 feet, would give 32,000 H.P. In Messrs. Holgate, McDougall & Ker's report for the city of Ottawa, High fall is given as capable of developing a head of 180 feet, with an output at the generator terminals of 40,000 H.P. High fall also has the great advantage of being on a very fine navigable river, watering a richly timbered country where there are deposits of graphite, phosphate of lime, mica and other minerals.

The James MacLaren Company, of Buckingham, acquired this water-power in 1901.

3. The Buckingham and Rheaume falls, near the mouth, have a total capacity of over 50,000 H. P.

Gatineau River

This is one of the largest tributaries of the Ottawa, and is some 225 miles long, with a drainage area of 9,500 square miles. Like the Ottawa, it is broken by falls and rapids capable of generating a large amount of power.

The Six Portages rapids on this river are a series of rapids which, altogether, are nearly five miles long. They extend from lot 14 of the first range of the township of Kensington to lot 51 of the third range of the township of Cameron. Their aggregate capacity has been estimated at 16,500 H.P.

The possibilities of development at Chelsea have been very carefully studied in the interest of the city of Ottawa, with a view to transmitting power to that city, by Messrs. H. Holgate, A. McDougall and N. J. Ker. In their report on this, they say, in part:

"Without going into all the details, which, however, have all been carefully studied, we would say that the area drained by the Gatineau river is about 9,000 sq. miles, or a little more. The ascertained minimum flow of the river is about 6,000 cubic feet per second, which is liable to reduction for short periods in excessively dry seasons, which occur in most rivers at intervals. As a basis for commercial development it would be proper to design the development works for the utilization of a flow of at least 7,500 cubic feet per second.

"Messrs. Gilmour & Hughson, owners of the property, have already studied the question of this development to some extent and, according to their plans, contemplate using 55 feet head. However, upon examination by us of the physical features of the river, we find that this plan is open to serious objection, owing to the fact that it does not permit the raising of the river sufficiently to drown Eaton chute, about three miles above Chelsea island, and the obliteration of Eaton chute is necessary to ensure the freedom of the power from interruption due to the formation of frazil. With Eaton chute drowned, there will be a body of quiet water for about eight miles above Chelsea, which will render the power reliable at all times, and the raising of the head water to this extent increases the potentiality of the river here by 45 per cent. owing to the fact that the working head will be 80 feet instead of 55 feet. The conditions are, therefore, that the development should be made on the basis of 7,500 cubic feet flow per second, operating under a head of 80 feet.

"The total development is equivalent to 50,000 H.P. at the outgoing terminals of a power house at Chelsea.

"As this power site is an ideal one for the establishment of a pulp and paper industry, it was not surprising to us to learn that the proprietors have this in view as a means of utilizing a part of the power. A plant

DAM ON CHAUDIERE RIVER, NEAR LEVIS, QUE.

for this purpose, built on a generous scale, would require a maximum of, say, 20,000 H.P. to 25,000 H.P., leaving 25,000 H.P. for other purposes."

Since the publication of the above report further observations show that the flow of the river has gone down as low as 3700 cubic feet per second (Ottawa River Storage Report for 1909-10, p. 66.) However, as this seems to have occurred during an exceptionally dry year, a minimum flow of 5,700 cubic feet per second has been assumed in the tables for the sites on the lower portion of the river.

District No. II.

River du Loup

This river is a navigable stream in the county of Maskinonge. Its basin embraces an area of about 600 square miles, of which about 550 are above St. Paulin, where the highest fall on the river (chute à Magnan) is situated. The head here is 120 feet, giving 2,000 H.P.

At a short distance below the chute à Magnan, two falls are met with at a distance of about 200 feet from each other, each having a height of 25 to 30 feet. Their collective capacity, at low water, is about 1,000 H.P. Most of these water-powers were conceded in 1907 to Mr. Henri L. Auger, of Montreal.

Maskinonge River

The Maskinonge river ranks among the important streams this district. The total area of its basin is nearly 450 square miles. The river proper takes its rise in the lake of the same name, four to five sqnare miles in area. Maskinonge lake might be made an important reservoir to regulate the flow of the Maskinonge river. Its banks are everywhere high enough, except in the neighbourhood of the head of the river in question.

Mr. C. E. Gauvin,of the Department of Lands, Quebec, investigated several cascades of some importance along the course of this river. Among these were Lauzon fall, with a possible development of 900 H.P., the Post fall of 540 H.P., and the great fall of Ste. Ursule, a very remarkable water-power, with a head of 220 to 230 feet and a capacity of 4,000 H.P. Mr. Théodore Lefebvre, of Montreal, acquired all these powers in 1907.

L'Assomption River

On this river, in the county of Joliette, a fall called the Mont-à-peine is worthy of note. The water-power here possesses remarkable facilities for development.

Ouareau River

This stream flows through the county of Montcalm. It is the chief branch of l'Assomption river, and, from certain points of view, is more important than the latter itself above their confluence, as it is fed by two large lakes, lake Archambault and lake Ouareau, which could be used as reservoirs to regulate the flow. The average distance of these three falls from the nearest station of the Canadian Northern Railway is about eight miles.

District No. III.

St. Maurice River

The drainage area of this river and its tributaries is 16,200 square miles in extent, and may be divided into —the settled portion, and the forested portion. The settled portion, whose natural centre is the city of Three Rivers, on the St. Lawrence, contains a considerable farming population. The forested portion of the St. Maurice region, covers an area of over 15,000 square miles. This territory contains, throughout its area, valuable pine, spruce, cedar and hardwood. There is also an abundance of iron, mica, and other minerals. The most important point to note is that nature has distributed throughout this region, side by side with the raw material, great water-powers capable of being easily developed.

The St. Maurice river, which waters the whole of that vast territory, is one of the largest tributaries of the river St. Lawrence. It flows into the latter near Three Rivers and takes its rise in the wathershed dividing the St. Lawrence slope from that of Hudson bay. The St. Maurice flows from west to east, about 350 miles, through a mountainous region, and is broken here and there by a series of cascades. The more important of these are the Shawinigan, La Tuque, Grand'mère and the rapide des Hêtres, nearly all of which are utilized by large industrial concerns.

There is a considerable storage in the upper river, in the lakes used by the lumber interests; and the different water-power users on the river are now endeavouring to plan in collaboration with the Provincial Government, works that will utilize the natural reservoirs which exist at the headwaters of the river.

District No. IV.

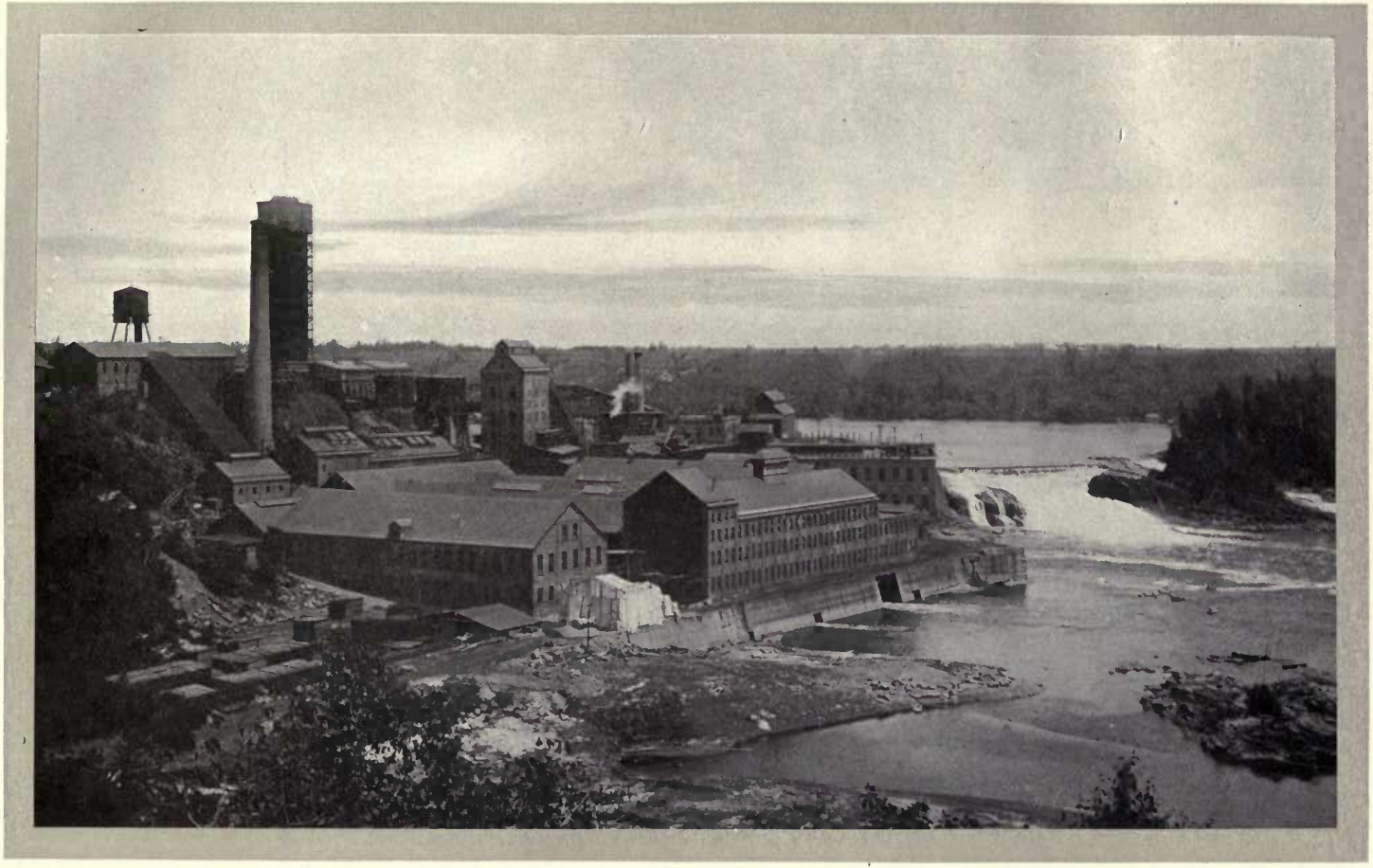
Ste. Anne River

On the great plateau of St. Féréol, behind St, Joachim, at a distance of four or five miles from the St. Lawrence, is a series of falls known as Seven falls. The head here is one of the highest known in Canada, 375 feet. It is estimated that from these cascades formed by the Ste. Anne river, an amount of energy equivalent to 5,000 H.P. can be obtained.

The Great fall on this river is distant a couple of miles from the shore of the St. Lawrence, in a fold of the St. Joachim mountain. It is encased in a narrow and steep gorge. The head is 190 feet and there is a possible minimum development of 2,500 H.P.

Montmorency River

The Montmorency falls have a head of nearly 270 feet. The tramway system in Quebec city and the suburban service to Ste. Anne de Beaupré are operated by power from this fall, which also supplies electrical energy in Quebec for other purposes and operates a large cotton mill situated at the foot of the falls.



LAURENTIDE PAPER COMPANY'S PLANT, GRAND'MERE, QUEBEC

Jacques Cartier River

The Jacques Cartier Company, a subsidiary company of the Quebec Railway, Light, Heat & Power Company, has leased one of the water-powers in this river and supplies current for street lighting to the city of Quebec, besides furnishing light and motive power to many private establishments. Four powers of some importance at Pont Rouge, on the same river, are also to be noted. The power from the Jacques Cartier river would be greatly increased if the waters of Jacques Cartier lake were conserved by storage works. The water-powers of the Jacques Cartier, and all the other rivers which take their rise in the Laurentides National Park possess a special importance which they owe to the fact that they all drain heavily wooded lands.

Batiscan River

Another very interesting river, from the point of view of its numerous water-power potentialities is the Batiscan. The Quebec and Lake St. John railway follows its valley for a considerable distance. It is broken by many falls and rapids. One of these occurs near the line of the Quebec & Lake St. John railway, below the mouth of the Jeannotte river, 81 miles from Quebec. It is estimated that 1,000 H. P. can be obtained from it. Other power sites nearer the mouth are of more importance, and are only partly developed.

The total drainage area of this river is about 1,700 square miles, of which over 100 square miles are in lakes. There are over a hundred of these, varying in area from 26 square miles (lake Edward) to 0.2 square miles.

District No. V

Saguenay River

This is one of the great tributaries of the St. Lawrence, and flows out of lake St. John by two channels, the Grand Discharge and the Little Discharge. These two channels, separated by Alma island, unite at a point nine miles farther down. Its total drainage area is 35,900 square miles. The Saguenay could furnish water-powers of great importance, especially at the chute à Caron, the Little Discharge and the Grand Discharge.

It is broken by a series of falls between the chutes à Caron and the Shipshaw river, whose capacity is estimated at over 150,000 H.P. They are owned by Mr. Thomas L. Wilson, but have not yet been utilized.

Ashwapmuchuan River

This river enters lake St. John a mile and a half north-west of St. Prime. It is three-quarters of a mile wide at its mouth, is four hundred feet wide a hundred miles farther up, and is navigable to St. Félicien. It is true that the forest land drained by the Ashwapmuchuan formerly suffered through fires, but, even in its present state, a vast field for lumbering still remains. Mr. J. C. Langelier, Superintendent of Forest Rangers, is of the opinion that

in the portion of this territory above Bear falls, ten million cords of white and black spruce of the best quality for making pulp and paper could be cut.

Peribonka River

The largest of the tributaries of lake St. John is the Peribonka river. Its length, from the mouth to the source, is about three hundred miles, while its width, in some places, is from one-third of a mile to a mile. It has a drainage area of 12,000 square miles.

This river, which is navigable for a distance of fourteen miles, is fed by a large number of lakes, some of which are 25 miles long, so that the volume of its waters is not seriously affected by summer droughts.

From the terminal point of steam navigation, about 14 miles from lake St. John, and for a distance of five to six miles as one ascends the river, it forms a series of seven cascades or falls, one above the other, whose total capacity has been estimated at 80,000 H.P.

Mistassini River

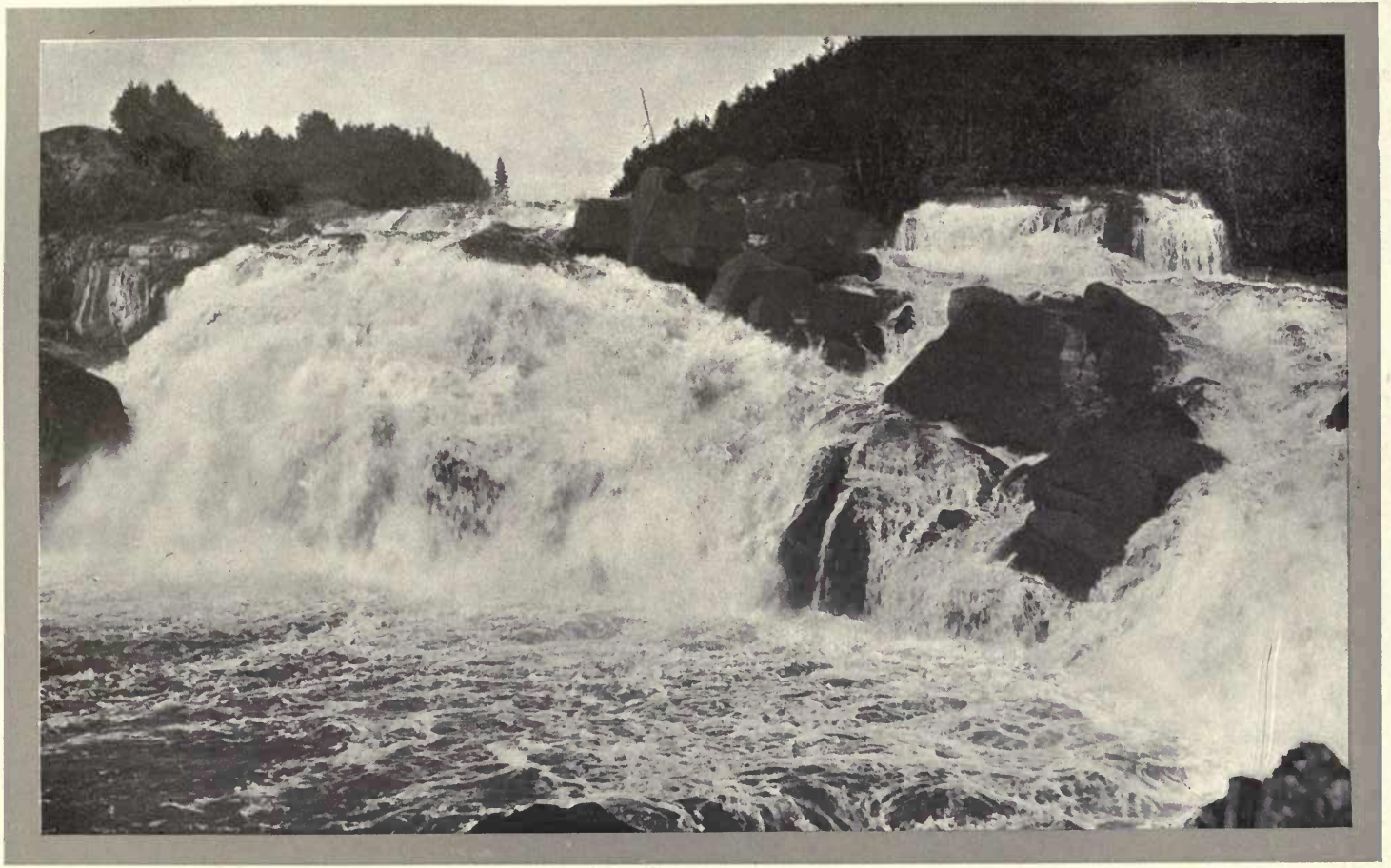
This is a large stream 200 miles long and three miles wide at its mouth. It borders the townships of Parent, Racine, Albanel and Pelletier, and falls into lake St. John at the extremity of Racine township. It has a drainage area of 9,000 square miles. It is navigable for a distance of 18 miles, and contains several notable cascades and rapids. The first falls are at the terminus of steamboat navigation, about 18 miles from the mouth of the river. There are two other falls, 11 and 16 miles respectively above the first, and finally at the 120th mile there is a splendid fall 80 feet high.

So much for the chief sources of power of the lake St. John region. Some of them are already used for industrial purposes on a large scale; but most of them are still awaiting capital for development.

Chicoutimi River

The magnificent cascade at the mouth of this river, in the town of Chicoutimi has a minimum capacity estimated at over 13,000 H.P. A syndicate has installed here one of the largest pulp mills in the province. At the beginning of its operations, the Chicoutimi pulp mills were turning out 14 tons of wood pulp daily. At present, the company has so increased its plant that the mills can now produce 100 to 150 tons of pulp per day. All this output is shipped to the English and French markets in steamships which load in the port of Chicoutimi. Shipments have also been made for some years past, to the United States.

In the same region is the river au Sable, whose power is estimated at 3,000 H.P. This has been utilized since 1901 by the Jonquières Pulp Company.



CHICOUTIMI FALL, CHICOUTIMI RIVER, QUE.

District No. VI

Hamilton River

This river, which empties into the Atlantic ocean, forms part of the boundary between the province of Quebec and Ungava peninsula. It is about seven hundred miles long and has a drainage area of 29,100 square miles. According to Dr. A. P. Low, Deputy Minister of the Department of Mines, the Grand falls of the Hamilton river have a perpendicular fall of 302 feet, while, if we include a series of smaller falls and rapids, above and below, extending over a distance of 12 miles, the total fall is 760 feet. In his report describing the Grand falls, Dr. Low says in part: "Such a fall (760 feet) would not be extraordinary for a small stream, in a mountainous country, but is phenomenal in a great river like the Hamilton. The basin into which it precipitates itself at this point is nearly circular and about 200 yards in diameter. It is surrounded on all sides by nearly perpendicular rocky walls, 500 feet high, except at the narrow cut at the head of the falls, and where the river issues from the basin. The noise of the fall has a stunning effect, and although deadened because of its enclosed situation, can be heard for more than ten miles away, as a deep, booming sound. The cloud of mist is also visible from any eminence within a radius of twenty miles."

Other rivers of importance in this district are the Natashkwan, Romaine, Moisie, Pentecôte, Manikuagan, Outarde and Bersimis, which flow into the Gulf of St. Lawrence and have falls at, or near, their mouths affording easy development and exceptional transportation facilities, being accessible both from the ocean and that great inland waterway, the St. Lawrence river.

Manikuagan River

This is one of the large rivers on the north shore of the St. Lawrence and empties into the latter river 205 miles below Quebec. Its length is 350 miles and it is broken by numerous cascades. Its drainage area is 15,000 square miles. Experts found that it would be comparatively easy to utilize the immense water-powers on this river. In 1906, a French syndicate leased the first falls, but has not yet begun to utilize them.

The forests of the region, which cover a very large extent of country, consist of white birch, white and black spruce, aspen, poplar, balsam, fir, balm of Gilead, black and yellow birch and banksian pine.

Rivière aux Outardes

Although smaller than its neighbour, the Manikuagan, the rivière aux Outardes is one of the finest streams flowing into the St. Lawrence. Mr. J. Bignell, Q.L.S., who examined it, estimates its average depth at 8 feet and its width as varying from 450 to 1,000 feet. It has a drainage area of 7,000 square miles. The principal falls are seven and a half miles from pointe

aux Outardes. The height of these cascades is about 200 feet. According to the calculation made by Mr. J. C. Langelier, in 1901, their capacity would be 180,992 H.P., but a more recent estimate gives 59,000 H.P. as the minimum. There is no access by navigation to these falls; but it would be easy to connect them with the falls on the Manikuagan by a tramway or railway.

The forest along this river, whose length is 300 miles, equals that of the Manikuagan basin. There is an abundance of pulpwood. According to official explorers, two cords per acre could be obtained. This would represent a total of 9,400,000 cords.

District No. VII

Magdalen River

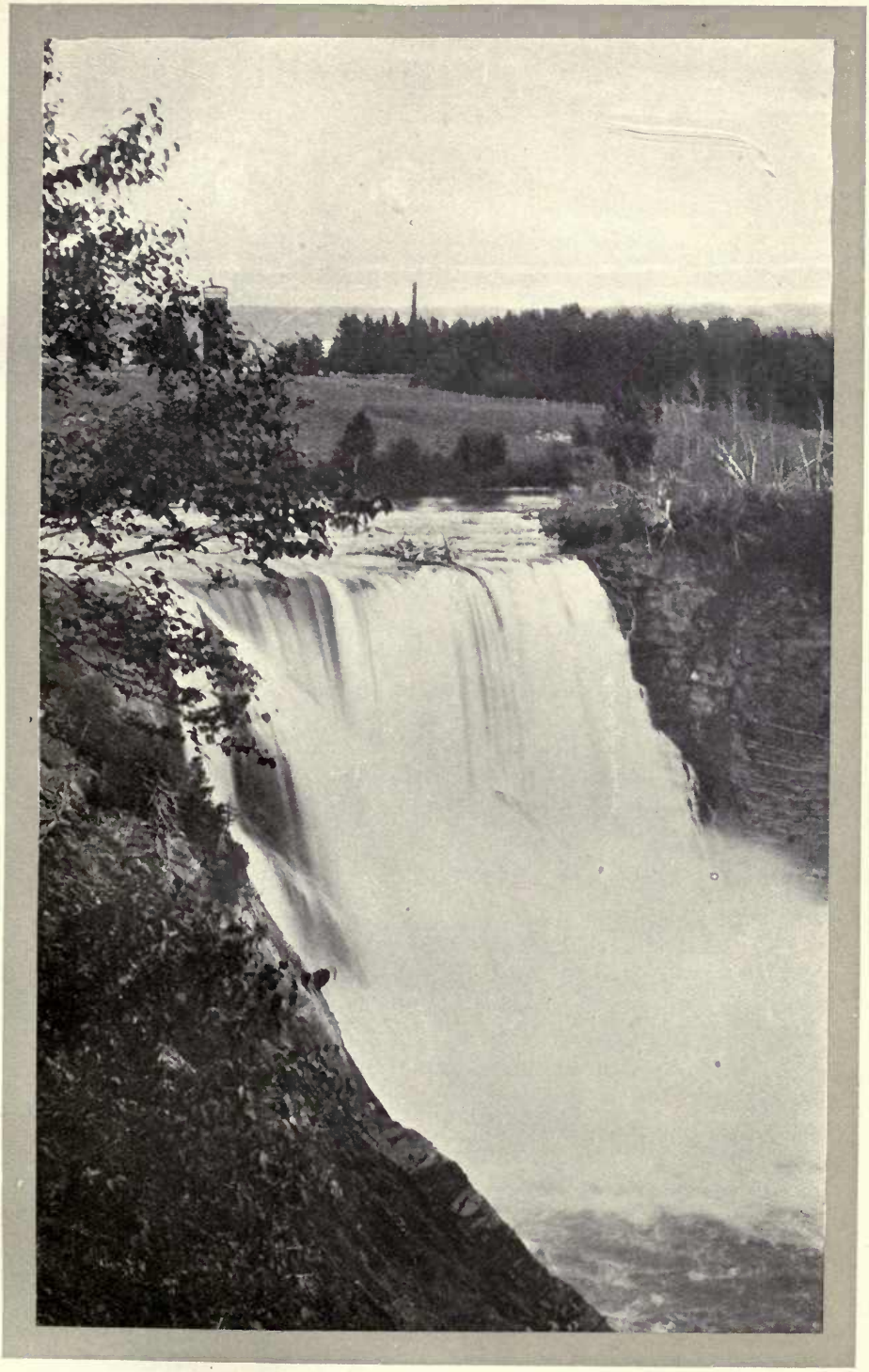
The Great fall (Grande chute) of the Magdalen is only seven and a half miles from the mouth of this river, whose drainage area is 450 square miles. This cascade is perpendicular and the water falls from a height of 62 feet. With a dam 15 feet in height to form a head race, it would be possible, according to Mr. J. C. Langelier, to get a total head of 77 feet, capable of developing 13,000 H.P. during the low-water period of ordinary seasons. Besides the Great fall there is also the Little fall (Petit Sault), ending in a series of rapids and cascades, which begins at the foot of the Great fall. According to Mr. J. C. Langelier, a dam 55 feet high, erected 1,500 feet above the fall, would give a head of 130 feet at the foot of the latter, with a capacity of 22,000 H.P. in the ordinary stage of the water, and of at least 6,680 at the very lowest stage of the water.* The water-powers of the Magdalen were adjudged, in 1902, to be the property of Mr. Chas. W. Mullen, of Bangor, Maine.

Little Cascapedia River

In the county of Bonaventure is the Little Cascapedia river, 75 miles long and with a drainage area of 700 square miles, flowing from the east, and parallel to the great river of the same name. It runs through the whole township of New Richmond. The falls on this river were granted, in 1901, to the New Richmond Lumber Company. With a head of 22 feet, 2,400 H.P. could be obtained, but a dam can be built to raise the head to 50 feet, giving 5,000 H.P. The minimum discharge is 970 cubic feet per second. It should be noted that in order to obtain the 50 foot head, valuable farm lands would have to be flooded.

By erecting storage dams at different points on the river or on its tributaries, above the rear line of New Richmond, an almost constant discharge, much greater than the 970 cubic feet per second above referred to, could be obtained and with this, of course, a greater constant power would result.

* Report of Department of Lands, Forests, and Fisheries, Quebec, 1901, p. 157



METIS FALLS, METIS RIVER, MATANE, QUEBEC

District No. VIII

Chaudière River

Fifty small streams and some twenty lakes feed this river whose drainage area is 2,600 square miles. The Chaudière falls, especially in the spring, when the water is at its highest stage, are very imposing. They are utilized by the Canadian Electric Light Company, to operate the Lévis County railway, and furnish electric light to Quebec, Lévis and the surrounding municipalities.

Etchemin River

The Etchemin river, which takes its rise in the highlands of Bellechasse and which, from St. Anselme, in the county of Dorchester, flows close to the Chaudière river, is another important watercourse. It empties into the St. Lawrence three miles above Quebec and is broken in its course at St. Anselme, St. Jean Chrysostôme and St. Romuald by several small falls, which are utilized by a number of mills.

Rivière du Sud, Ouelle and du Loup

In the vicinity of the Intercolonial railway, to the east of Quebec, the falls susceptible of being utilized for industrial purposes are equally numerous. They are found on the river du Sud at St. Raphael and Montmagny; on the Bras St. Nicholas, at St. Cyrille de L'Islet, and at St. Aubert on the river Trois-Saumons. A little farther down the line we meet other water-powers on the river Ouelle, at St. Pacôme, in the township of Ixworth, on the Kamouraska river, at St. Paschal, at Trois-Pistoles, and then at River du Loup, on the river of the same name, where a splendid fall has been developed to operate a pulp mill. Unfortunately definite figures could not be secured for some of the above, and for this reason they are not included in the tables.

District No. IX

St. Lawrence River

The question of diverting water for power purposes on this river, between lakes St. Francis and St. Louis is a very important one. There are several mills and plants utilizing hydraulic energy at this point, the most important of which are the Montreal Cotton Company's mills at Valleyfield, and the Montreal Light, Heat & Power Company's plant at Cedars. The Canadian Light and Power Co. have just completed the construction of a plant at St. Timothée to transmit electrical energy to Montreal, using the old Beauharnois canal for an intake. Another company proposes to draw water for power purposes at the head of the Coteau rapids through the so-called St. Louis feeder, enlarging it and constructing a canal parallel to the St. Louis river as far as the foot of the Cascades rapids.

All this will mean a large amount of water drawn from lake St. Francis through artificial outlets, and fear is entertained that the level of this

lake will be so lowered as to interfere with navigation. Mr. J. L. Michaud, of the Public Works Department, in a report on this problem, comes to the following conclusions: "I do not think that it will be advisable to allow any company to divert water from lake St. Francis without building remedial works. It would not be advisable either to completely close the outlet of lake St. Francis, as many of the boats go down the rapids. The most practical way of solving the problem would be to block a portion of the river, which has now a discharge at least equal to the discharge required by the companies. This dam should be movable, of sluice gates or stop logs type, and should be controlled by the Government.

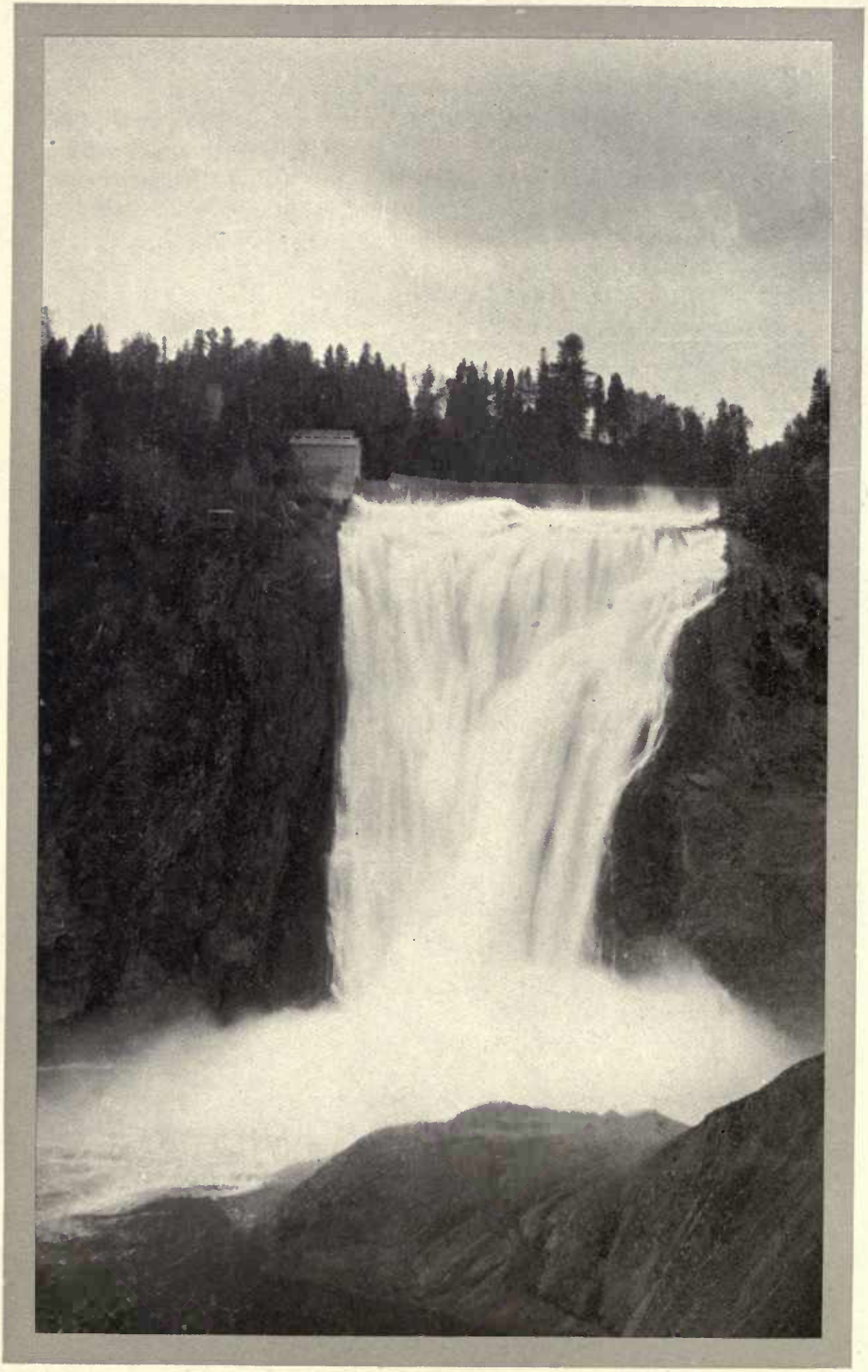
"The fall between lake St. Francis and lake St. Louis totals 83 feet, divided in three separate pitches: the Rapide du Côteau, Rapide des Cêdres, and Rapides des Cascades. A partial dam at the head of the first pitch would tend to raise the water at that point, but would lower it at the other falls. There is no complete set of soundings throughout the rapids, but according to those shown on the plans of the Public Works Commissioners made in 1854, and on the plan of the Hydrographic Survey, after a personal examination made by shooting the rapids in one of the Richelieu and Ontario Navigation Company's boats, it would seem as if the blowing up of a few points, and the building of a submerged dam at the head of the other pitches, would be sufficient. In order to decide that question, it would be necessary to make some accurate gaugings of the discharge through this channel, but judging by the data at hand, there is no doubt, if proper compensating or remedial works were to be built, water could be diverted from the lake without interfering with navigation.

"But before any work is commenced, plans and descriptions should be submitted to the Honourable Minister for his approval, and the execution of the proposed works should also be supervised by some engineers or officials of the Department."

Subsequently, the case was presented before the Dominion Government by the interested parties, and, as a result, the matter was referred to a board of experts to report upon.

The exceedingly low ratio of the low-water flow to the high-water flow—about 1 to 2—makes the St. Lawrence a very valuable one for power purposes. This is due to the Great lakes which form immense balancing reservoirs and give it a steadiness and flow not possessed by any other great river. This uniformity of discharge also makes it absolutely unique from a navigation standpoint.

As the interests of navigation must always be paramount and, particularly in view of the probability that the St. Lawrence canals will be deepened in the near future, no works should be permitted that will injure this



MONTMORENCY FALL, MONTMORENCY RIVER, QUE.

magnificent river from a scenic point of view or that may be detrimental to the interests of navigation, either at the present time or in the near future, when the largest lake vessels will descend the river to Montreal. Twelve years ago the largest lake vessels were 250 feet long and had a capacity of 2,500 tons. To-day they carry from 10,000 to 15,000 tons. What will they be twelve years hence?

Richelieu River

This is one of the principal tributaries of the St. Lawrence. It takes its rise in the state of Vermont, some 115 miles south of the boundary line (45th parallel) between Canada and United States and receives, by its numerous tributaries, the waters of a basin whose area is estimated at 9,500 square miles. The surface of the part of this area that lies above Chambly basin is equivalent to about 9,000 square miles. From a point situated approximately a mile below Ste. Thérèse island, the Richelieu river may be said to be an uninterrupted rapid to Chambly basin, or for a total distance of four and a half miles, and affords fine mill sites on both banks. Above Chambly basin, the Richelieu has always been famed for its water-powers and for many years back mills have used this stream for power purposes.

In the village of Richelieu are the works of the Chambly Manufacturing Company and the Willett works, of lesser importance.

Negotiations are now in progress to build a dam, at a point seven miles below St. Johns, right across the river, in connection with the Chambly canal, thus drowning out the St. Johns rapids. This will, at the same time, create a water-power of about 3,500 H.P., which the Government proposes to offer for rental.

Near the village of St. Ours, the river has a fall of 10 feet and is capable of developing 2,500 H.P. It is important to note that there is no frazil or anchor ice in the river at St. Ours, and there is the further very great advantage of being near Montreal and Sorel.

St. Francis River

This river flows into the St. Lawrence from the south. It has a large number of tributaries, some of them, like the Magog, quite large. The basin of the St. Francis is rather narrow near the mouth, but broadens out in the upper portion, where it is fed by good-sized lakes, among which are the Memphremagog and Massawippi in the south-west, and the St. Francis and Aylmer in the east.

This river is very rich in water-powers; on the river itself these are estimated at about 12,000 H.P., while, distributed on its different tributaries, are about 10,000 H.P. A large percentage of these water-powers

is now being utilized for different industries, such as the manufacture of textiles, lumber and paper, and the generation of electricity.

Bécancour River

This river traverses the counties of Megantic and Nicolet. Its course is broken in several places by falls and rapids. One of the largest, known as Maddington fall, is situated in the village of Daveluyville at a short distance only from the Intercolonial Railway bridge. This fall affords a water-power with many advantages both as to situation and on account of the facilities offered for its development. The height of the fall at the village is 44 feet, and the minimum flow of the river about 185 cubic feet per second. This would give 1,000 H.P.

District No. X

The main arteries of this district are the Eastmain, the Rupert, and the Nottaway rivers. The Harricanaw river is another important stream in this district. Except near the mouth, it flows through Quebec.

All these rivers have been explored, either by members of the Geological Survey or by surveyors for the Department of Lands, Quebec; in some cases by both. The reports on these explorations give numerous figures respecting the situation and heights of falls and rapids along rivers followed by the explorers but, naturally, do not attempt to indicate the minimum flow of the rivers. In some cases, what appears to be the mean or average flow is given, but this can hardly be used, even as a guide, to obtain the minimum flow—the indispensable factor in order to arrive at the horse-power which can be depended upon throughout the year. An approximation has been computed by proportioning the flow to the drainage area above the point under consideration; the factor used to convert drainage to minimum discharges of rivers was chosen as 0·4 cubic feet per second per square mile, which is the same factor used by Mr. L. V. Rorke for the rivers on the Ontario slope of James bay where similar conditions should obtain. If this factor (0·4) seems a little high, this will be more than compensated, on the whole, by the fact that several sites described by the explorers simply as "rapids" or "falls" have been unavoidably omitted as no figures were obtainable.

The Nottaway river and its tributary, the Bell, being nearest the present settled portion of the Province, will probably be the first to attract the attention of capital; they are both broken by numerous falls and drain innumerable lakes which extend over a large area and which could be used to regulate the flow.

The Rupert river, whose basin lies a little farther north, is fed by the large Mistassini lake and also affords numerous water-power sites of large capacity.

The Eastmain river flows parallel to the Rupert and some 50 miles further north. It forms part of the boundary between the province of Quebec and the territory of Ungava. It is remarkable for its numerous high falls, there being a series of no less than four, of 100 feet or more in height, in a stretch of less than one hundred miles.

DISTRICT No. I—TRIBUTARIES OF THE OTTAWA RIVER

Power Site	Available		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				REMARKS
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
Quinze river:* (*the portion of the Ottawa between Quinze lake and lake Timiskaming; drainage area*=9,500 *sq. m.*).									
1st lower falls (2 m. from North Timiskaming)	16	5,700	.....	.....	.....	.....	.....	.....	
418. 2nd lower fall	5	2,000	.....	.....	.....	.....	.....	.....	
3rd lower fall	27	9,800	.....	.....	.....	.....	.....	.....	
4th lower fall	24	8,700	.....	.....	.....	.....	.....	.....	
419. Island rapid	95	32,000	.....	.....	.....	.....	.....	.....	
420. Pipestone rapid	9	3,060	.....	.....	.....	.....	.....	.....	
421. Kakaki rapid	46	15,000	.....	.....	.....	.....	.....	.....	
Cypress rapid	20	6,800	.....	.....	.....	.....	.....	.....	
422. Maple rapid	18	6,120	.....	.....	.....	.....	.....	.....	
Head rapid	13	4,420	.....	.....	.....	.....	.....	.....	
Rigaud river:									
423. Rigaud	30	100	.....	.....	.....	.....	100	100	Used for flour-milling
North river:									
424. St. Andrews	11	250	.....	.....	.....	.....	100	100	Grist mill
425. Lachute	12	250	.....	.....	.....	.....	250	250	Lumber mill
425. "	40	1,700	.....	.....	.....	.....	500	500	Felt manufacture

* For the Ottawa river between Montreal and Lake Timiskaming, see pp. 147-149

426.	St. Jérôme	23	250	.....	.....	.....	650	.....	650	Paper mill; uses steam auxiliary
	"	8	400	.....	.....	.....	.....	400	400	Lumber and grist mills
	"	13	500	.....	175	175	.....	125	300	Electricity used in St. Jérôme
	"	30	500	.....	.....	.....	500	.....	500	
427.	Sanderson rapids (2 m. above St. Jérôme)	70	1,600	.....	.....	.....	.....	.....	.....	
428.	Ste. Adèle	98	1,300	.....	.....	.....	1,300	.....	1,300	
Cambria river:										
429.	Cambria	20	60	.....	.....	.....	.....	60	60	
Rouge river:										
430.	Seven chutes to Nigger rapid	80	5,000	.....	.....	.....	.....	.....	.....	
	Table fall	50	3,000	.....	.....	1,500	.....	.....	1,500	Electric plant supplying Calumet, Grenville, Hawkesbury, etc.
	Walker chute	15	900	.....	.....	.....	.....	.....	.....	
431.	La Cloche and McTavish fall	45	2,700	.....	.....	.....	.....	.....	.....	
432.	Rockaway fall	15	800	.....	.....	.....	.....	.....	.....	
	Huberdeau fall	15	800	.....	.....	.....	.....	.....	.....	
433.	Bluet fall	15	750	.....	.....	.....	.....	.....	.....	
434.	Iroquois fall	25	1,250	.....	.....	.....	.....	.....	.....	
435.	Rapide Plat (8 m. below Nomining river)	11	500	.....	.....	.....	.....	.....	.....	There is a total descent of 43 ft. in 1¼ mile
436.	On Devil river (6 m. from St. Jovite)	15	220	.....	.....	.....	.....	.....	.....	
437.	From Trembling Mt. lake	36	800	.....	.....	.....	.....	.....	.....	By using lake as reservoir
Petite Nation river:										
438.	Oxbow falls (Lot 4, Hartwell)	15	400	.....	.....	.....	.....	.....	.....	
Lièvre river: (*drainage area* 4,000 *sq. m.*)										
439.	Rheaume fall	196	35,000	.....	.....	.....	.....	.....	.....	
	Buckingham	98	16,000	.....	.....	.....	8,500	.....	8,500	Development has a 65 ft. head
440.	High fall (24 m. above Buckingham)	180	32,000	.....	.....	.....	.....	.....	.....	Including two rapids below
441.	L'Orignal rapid (80 m. from mouth)	19	2,200	.....	.....	.....	.....	100	100	

	Power Site	Available		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				REMARKS
		Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
Gatineau river: (*drainage area* 9,500 *sq. m.*)										
	Farmer rapid	17	10,600	.....	.....	.....	.....	.....	.....	
	Chelsea rapid	50	31,000	.....	.....	.....	.....	.....	.....	
442.	High fall, Manitou and Hardwood rapids and Eaton chute	80	50,000	.....	.....	.....	.....	.....	.....	
443.	Cascades	22	13,700	.....	.....	.....	.....	.....	.....	
444.	Paugan fall and rapid	37	23,000	.....	.....	.....	.....	.....	.....	
	Mountain rapid	20	12,500	.....	.....	.....	.....	.....	.....	
445.	Bully rapid	23	12,700	.....	.....	.....	.....	.....	.....	
	"Six Portages" (70 m. from mouth) include the following:									
	(a) Cedar rapid	9	3,200	.....	.....	.....	.....	.....	.....	
446.	(b) Boom rapid	14	4,960	.....	.....	.....	.....	.....	.....	
	(c) Corbeau rapid	15.8	5,500	.....	.....	.....	.....	.....	.....	
	(d) Head of Six Portages rapid	8	2,800	.....	.....	.....	.....	.....	.....	
	Des Eaux rapid	8	2,700	.....	.....	.....	.....	.....	.....	
447.	St. Joseph rapid (7 m. above Maniwaki)	15	5,200	.....	.....	.....	.....	.....	.....	
	Big Eddy fall	12	4,200	.....	.....	.....	.....	.....	.....	
	Burnt fall	15	5,200	.....	.....	.....	.....	.....	.....	
448.	Mountain fall and rapid	34	12,000	.....	.....	.....	.....	.....	.....	
	Quatre Pattes fall	15	5,200	.....	.....	.....	.....	.....	.....	
	Bitobi rapid	12	4,200	.....	.....	.....	.....	.....	.....	

449.	Sturgeon fall	15	2,300	.....	.....	.....	.....	.....	.....	
	Hardwood rapid	65	9,800	.....	.....	.....	.....	.....	.....	
	Snake fall	35	5,200	.....	.....	.....	.....	.....	.....	
450.	E. Branch, near Nat. Trans. Ry. crossing	30	1,000	.....	.....	.....	.....	.....	.....	
Kipawa river: (*discharge of lake Kipawa, which will be used as a reservoir; area 124 sq. m.*)										
451.	"Bend of the river"	54	3,700	.....	.....	.....	.....	.....	.....	12,000 H.P. could be obtained with reserve dam on lake

QUEBEC

DISTRICT No. III—NORTH SHORE OF ST. LAWRENCE RIVER, BETWEEN THE OTTAWA AND ST. MAURICE RIVERS

Power Site		Available		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				Remarks
		Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
Yamachiche river:										
452.	St. Elie de Claxton	23	60	.....	.....	.....	.....	60	60	
River du Loup: (*Maskinonge county*)										
453.	Two cascades (1,000 ft. below Magnan fall)	55	1,000	.....	.....	.....	.....	.....	.....	
	Magnan fall (½ m. below C.N.Q. Ry.)	120	2,000	.....	.....	.....	.....	.....	.....	
454.	Chaudière fall	35	600	.....	.....	.....	.....	100	100	
	Hunterstown fall	25	400	.....	.....	.....	.....	.....	.....	
	Baribeau fall	15	276	.....	.....	.....	.....	.....	.....	
	Chute aux Trembles	60	1,080	.....	.....	.....	.....	.....	.....	
455.	On Six Falls branch	106	700	.....	.....	.....	.....	.....	.....	
	On Sorcier branch	138	1,086	.....	.....	.....	.....	.....	.....	Two lakes could be used as reservoirs
Maskinonge river:[a] (*total drainage area, 450 sq. m.*)										
456.	Ste. Ursule fall	225	4,000	.....	.....	.....	.....	.....	.....	
457.	Chute de Poste	30	540	.....	.....	.....	.....	.....	.....	
458.	Lauzon fall, near St. Didace	40	900	.....	.....	.....	.....	.....	.....	
Mattambine river:										
459.	St. Damien	14	25	.....	.....	.....	.....	25	25	

[a] Lake Maskinonge could be raised 10 ft. to 15 ft. to form a reservoir.

L'Assomption river:										
460.	Joliette	6	30	.....	.....	.....	.....	30	30	
	"	14	450	.....	.....	.....	450	.....	450	
461.	Mont-à-peine fall (s.w. of St. St. Jean-de-Matha)	100	2,360	.....	.....	.....	.....	.....	.....	
Achigan river: (*tributary of L'Assomption*)										
462.	L'Epiphanie	12	250	.....	.....	.....	.....	250	250	Lumber and grist mills
463.	Laurentides	.....	200	.....	.....	.....	.....	200	200	Lumber and grist mills
464.	Kilkenny	22	60	.....	.....	.....	.....	60	60	
Ouareau river: (*tributary of L'Assomption river, Montcalm county*)										
465.	Magnan fall, (1 m. from Rawdon village)	25	1,125	.....	.....	.....	.....	.....	.....	
	Darwin fall, (½ m. from Rawdon village)	66	3,000	.....	.....	.....	.....	.....	.....	
	Manchester fall (1 m. from Rawdon village)	37	1,700	.....	.....	.....	.....	.....	.....	

QUEBEC

DISTRICT No. IV—ST. MAURICE RIVER BASIN

Power Site	Available		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				REMARKS
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
St. Maurice river:									
466. "Les Forges" rapid (8 m. from mouth)	12	12,000	.....	.....	.....	.....	.....	.....	
467. Les Grès rapid, Fer-à-cheval rapid, Gabelle rapid (15 m. from mouth)	40	40,000	.....	.....	.....	.....	.....	.....	
468. Shawinigan falls (21 m. from mouth)	135	130,000	80,000	15,000	95,000	12,000	.....	107,000	Electricity transmitted to Montreal, Eastern Townships and Sorel with about 30 sub-stations feeding the different municipalities along the transmission lines; 30,000 H.P. of electrical energy is used in Shawinigan for the production of aluminum and carbide
469. Rapide des Hêtres (26 m. from mouth)	17	7,000	.....	.....	.....	.....	.....	.....	
Grand'mère fall	45	40,000	.....	.....	.....	17,000	.....	17,000	
470. Chutes des Piles	10	9,000	.....	.....	.....	.....	.....	.....	
471. La Tuque	100	85,000	.....	.....	.....	.....	.....	.....	Being developed for pulp and paper mill
472. Demicharge rapid	20	6,800	.....	.....	.....	.....	.....	.....	
Iroquois rapid	10	3,400	.....	.....	.....	.....	.....	.....	
Rocher rapid	10	3,400	.....	.....	.....	.....	.....	.....	
L'Isle rapid	37	12,500	.....	.....	.....	.....	.....	.....	
Weymontachi rapid	10	3,400	.....	.....	.....	.....	.....	.....	

Shawinigan river:									
468. Near Shawinigan Falls	.....	1,500	.....	.....	1,500	.....	.....	1,500	
River du Milieu: (*tributary of the Matawin*)									
473. Chute des Aulnaies	11	200	.....	.....	.....	.....	.....	.....	
473. Rapids above chute des Aulnaies	25	250	.....	.....	.....	.....	.....	.....	
Bostonnais river: (*drainage area 550 sq. m.*)									
471. Falls near La Tuque	26	800	.....	.....	.....	.....	.....	.....	Head could be raised to 36 ft. and, by storage in lake Najualand, power would be doubled
Vermilion river: (*tributary of the St. Maurice*)									
474. Iroquois fall (21 m. above La Tuque)	35	1,200	.....	.....	.....	.....	.....	.....	
Manuan River:									
475. 1st fall (4½ m. from mouth)	30	1,000	.....	.....	.....	.....	.....	.....	
Ribbon river:									
476. Rapids and falls near Nat. Trans. Ry. (mile 677)	80	1,000	.....	.....	.....	.....	.....	.....	

QUEBEC

DISTRICT No. IV—NORTH SHORE OF ST. LAWRENCE RIVER BETWEEN ST. MAURICE AND SAGUENAY RIVERS

Power Site	Available		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				REMARKS
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
Murray river:									
477. Murray Bay	26	.....	.....		350	.....	.....	350	
Ste. Anne-de-Beaupré river: (*Drainage area, 365 sq. m.*)									
478. St. Joachim fall	190	2,500	.....		.....	.....	.....	.....	
479. St. Féréol, seven falls	375	5,000	.....		.....	.....	.....	.....	
Petit-Pré River:									
480. Ange Gardien	.....	1,000	.....		.....	.....	175	175	Leather manufacture
Montmorency river:									
481. Montmorency fall	268	5,000	2,000	2,000	4,000	.....	1,000	5,000	Electricity used in Quebec (pop. 70,000) and suburbs; 1,000 H.P. used in textile mill
481. "Natural steps" dam	62	1,000	500	500	1,000	.....	.....	1,000	
Jacques-Cartier river:									
482. Pont Rouge	12	500	.....	50	50	.....	50	100	Electricity used in village (pop. 1,000)
483. St. Gabriel	30	1,000	500	1,500	2,000	.....	.....	2,000	Electricity used in Quebec (pop. 70,000); has steam auxiliary plant
Portneuf river:									
484. Portneuf	20	300	.....		.....	300	.....	300	

Ste. Anne-de-la-Pérade river:										
485.	St. Raymond (3 m. below village)	25	426	.....	.....	.....	426	.....	426	
	St. Raymond	15	180	.....	80	80	.....	100	180	Electricity used in St. Raymond (pop. 1,500)
Charest river:										
486.	Ste. Anne-de-la-Pérade	16	80	.....	.....	.....	.....	80	80	
Batiscan river: (*drainage area* 1,700 *sq. m.*)										
487.	Last Falls rapid	45	2,700	.....	.....	.....	.....	.....	.....	
	Grande chute (St. Narcisse)	55	3,300	800	1,140	1,940	.....	.....	1,940	Electricity used in Three Rivers (pop. 10,000)
	Chute Plate	23	1,380	.....	.....	.....	.....	.....	.....	
	Des Islets fall	45	2,700	.....	.....	.....	.....	.....	.....	
	Murphy fall	12	720	.....	.....	.....	.....	.....	.....	
	Somerville old mill	15	900	.....	.....	.....	.....	.....	.....	
488.	Falls just below Jeannotte river	17	1,000	.....	.....	.....	.....	.....	.....	
489.	Rickaby rapid (Little Batiscan river)	19	700	.....	.....	.....	.....	.....	.....	

QUEBEC

DISTRICT No. V—SAGUENAY RIVER BASIN*

	Power Site	Available		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				Remarks
		Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
Saguenay river:†										
	Chute à Caron	24	82,000	.....	.....	.....	.....	.....	.....	
	Cran-Serré (just below chute à Caron)	14								
490.	Rapids above L'Anse-de-Sable	15	153,000	.....	.....	.....	.....	.....	.....	
	Chute de L'Anse-Creuse (Grande Ile)	16								
491.	Little Discharge (St. Joseph d'Alma)	112	4,300	.....	.....	.....	.....	.....	.....	
Ha-ha river:										
492.	Grande-Baie (Chicoutimi county)	19	150	.....	150	150		.....	150	
Chicoutimi river:										
	Chicoutimi, 1st fall	45	3,000	.....	.....	.....	.....	50	50	
493.	Chicoutimi, 2nd and 3rd falls	150	10,000	200	300	500	7,000	.....	7,500	Electricity used in Chicoutimi (pop. 5,500)
	Falls 6 m. above Chicoutimi	35	2,300	.....	.....	.....	.....	.....	.....	
Shipshaw river:										
	Wilson dam	31	1,700	.....	.....	.....	.....	.....	.....	Dam built
494.	Murdoch fall	80	4,800	.....	.....	.....	.....	.....	.....	Part being developed
	Guimond fall	25	1,500	.....	.....	.....	.....	.....	.....	

* Other data, for which only approximate figures are available, are given on page 188.

† In a report for 1899, Mr. C. E. Gauvin gives a value of 30,520 cubic feet per second for the discharge of the river, but, a calculation based on the area of its drainage basin, gives a result of about 14,000 cubic feet per second.

495. Noyé, Gagnon and Portage chutes	50	2,500	.....	.....	.....	.....	.....	.....	
Sable river:									
496. Jonquières	65	3,000	.....	.....	.....	3,000	.....	3,000	
Muskosibi river: (*tributary of lake St. John*)									
497. Chute des Pères	42	12,000	.....	.....	.....	.....	100	100	
Ouiatchuanish river:									
498. At mouth	17	.....	.....	.....	200	.....	.....	200	Roberval electric plant
Ouiatchuan river:									
499. Ouiatchuan falls (Chicoutimi county)	250	13,000	.....	.....	.....	5,000	.....	5,000	
Metabetchouan river: (*tributary of lake St. John*)									
500. La Martine falls, upper group	67	2,900	.....	.....	.....	.....	.....	.....	
500. La Martine falls, lower group	86	3,700	.....	.....	.....	.....	.....	.....	
500. L'Epouvante fall (St. André-de-l'Epouvante)	50	2,100	.....	.....	.....	.....	.....	.....	
501. Les Cascades (17 m. from lake St. John)	32	1,300	.....	.....	.....	.....	.....	.....	
501. White falls (19 m. from lake St. John)	32	1,300	.....	.....	.....	.....	.....	.....	
Belle river:									
502. Hébertville (Chicoutimi county)	22	250	.....	250	250	.....	.....	250	

QUEBEC

DISTRICT No. VI—NORTH SHORE OF ST. LAWRENCE RIVER BELOW THE SAGUENAY AND THE HAMILTON RIVER BASIN

Power Site	Available		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				REMARKS
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
Ste. Marguerite river:									
503. Clark City (9 m. from mouth)	125	.....	.....	.....	.....	9,600	.....	9,600	
Outarde river: (*drainage area* 7,000 *sq. m*)..									
504. Falls and rapids 7½ m. from mouth.....	181	59,000	.....	.....	.....	.....	.....	.....	
Sault-au-Cochon river:									
505. 1st falls (1 m. from mouth) ...	60	2,000	.....	.....	.....	.....	.....	.....	
Escoumains river:									
506. Les Escoumains (Chicoutimi county).....	22	450	.....	.....	.....	.....	450	450	Lumber

DISTRICT No. VII—SOUTH SHORE OF THE ST. LAWRENCE RIVER, BELOW RIVER DU LOUP

Power Site	Available		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				REMARKS
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
Milnikek river:									
507. Dam near mouth	12	110	.....	.....	.....	.....	110	110	Head created by dam entirely
507. Milnikek	20	200	.....	.....	.....	.....	200	200	Used for lumber
Causapscal river:									
508. Causapscal	10	55	.....	.....	.....	.....	.....	.....	
Little Cascapedia river:									
509. Rapids at lot 22, R. 7, New Richmond	50	5,000	.....	.....	.....	.....	.....	.....	Creating the 50 ft. head would flood valuable farm lands
Little Bonaventure river:									
510. Ruisseau Leblanc	29	55	.....	.....	.....	.....	55	55	
Bonaventure river:									
511. Rapide Malin (6 m. above mouth)	6.2	900	.....	.....	.....	.....	.....	.....	
Port Daniel river:									
512. Port Daniel	18	80	.....	.....	.....	.....	80	80	
Metis river:									
513. Falls 2½ m. from Mount Joli village	115	3,000	.....	.....	.....	.....	.....	.....	There are three lakes which can be conserved

DISTRICT No. VII.—SOUTH SHORE OF THE ST. LAWRENCE RIVER BELOW RIVER DU LOUP—*Continued*

Power Site	Available		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				REMARKS
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
Rimouski river:									
514. Rimouski	52	500	.....	.....	.....	.....	2,700	2,700	Lumber
515. Grand Sault (16 miles from Rimouski)	50	300	.....	.....	.....	.....			

QUEBEC

DISTRICT No. VIII—SOUTH SHORE OF THE ST. LAWRENCE RIVER BETWEEN RIVER DU LOUP AND CHAUDIÈRE RIVER (INCLUSIVE)

Power Site	Available		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				REMARKS
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
River du Loup:									
516. Fraserville		500	.....	400	400	.....	100	500	Electricity used in Fraserville (pop
516. "	70	3,000				3,000		3,000	
Kamouraska river:									
517. Kamouraska	18	30	.....	.....	.....	.....	30	30	
Ferrée river:									
518. Vil. des Aulnaies (L'Islet co.)	25	30	.....	.....	.....	.....	30	30	
Rivière du Sud:									
519. Montmagny	27	1,500	130	100	230	1,200	.....	1,430	Electricity used in Montmagny (pop. 2,700)
Etchemin river:									
520. Etchemin bridge	24	300	.....	.....	.....	.....	300	300	Lumber
520. Etchemin bridge	10	50	.....	.....	.....	.....	50	50	Lumber
521. 4 m. from St. Henri-de-Lévis	77	1,000	.....	.....	.....	.....	.....	.....	Installation being completed by Dorchester Electric Co.
Chaudière river:									
522. Chaudière fall	140	3,500	1,000	2,500	3,500	.....	.....	3,500	Electricity used in Lévis and neighbourhood (total pop. 15,000) and also transmitted to Quebec
523. St. George (Beauce co.)	22	350	.....	350	350	.....	.....	350	

DISTRICT No. IX—SOUTH SHORE OF THE ST. LAWRENCE RIVER ABOVE CHAUDIÈRE RIVER, AND ST. LAWRENCE RIVER ABOVE MONTREAL

Power Site	Available		Electrical Energy Used, 1910 (Horse-Power)		Developed (Horse-Power)				REMARKS
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
Bécancour river:									
524. Maddington falls	44	1,000	.....	.....	.....	.....	.....	.....	
525. Lakes Sunday and Breeches	50 25 60	300	.....	.....	.....	.....	.....	.....	Using lakes as reservoirs
Nicolet river:									
526. Ste. Brigitte-des-Saults (Nicolet co.)	10	60	.....	.....	.....	.....	60	60	
527. Small trib. at Lorne (Richmond co.)	35	25	.....	.....	.....	.....	.....	.....	
St. Francis river:									
528. Drummondville	9	.....	.....	.....	.....	.....	90	90	Boot and shoe factory and iron smelter
528. Hemming falls (2 m. above Drummondville)	35	5,500	.....	.....	.....	.....	.....	.....	
529. Windsor Mills	16	2,000	.....	.....	.....	6,000	.....	6,000	Use steam and electric auxiliary
530. East Angus	.....	1,000	.....	.....	.....	1,000	.....	1,000	
531. Small tributary at Bishop Crossing	11	60	.....	.....	.....	.....	60	60	Used for lumber
532. Disraeli	.....	2,000	.....	.....	.....	.....	2,000	2,000	
532. "	.....	.....	2,500	.....	2,500	.....	.....	2,500	

Salmon creek: (*tributary of St. Francis*)									
533. Kingsbury	12	250	.....	.....	.....	.....	250	250	Used for lumber
533. Richmond	32	200	.....	200	200	.....	.....	200	Electricity used in Richmond (pop. 2,500)
Windsor river: (*tributary of St. Francis*)									
534. Stoke Centre	24	75	.....	.....	.....	.....	75	75	Used for lumber
Magog river: (*tributary of St. Francis*)									
535. Sherbrooke	16	535	.....	.....	.....	.....	535	535	Carpet factory
535. "	30	1,800	950	850	1,800	.....	.....	1,800	Electricity used in Sherbrooke (pop. 12,000).
535. "	65	4,000	.....	.....	3,000	.....	.....	3,000	Sherbrooke Power and Ry. Co's development
536. Nagle dam (Little Magog lake)	30	1,300	.....	.....	.....	.....	.....	.....	Flow regulated by British American Land Co.
537. Magog	10	500	300	200	500	.....	.....	500	
537. "	25	.....	.....	.....	.....	.....	2,100	2,100	Textile mill; use steam auxiliary
Massawippi river: (*tributary of St. Francis*)									
538. North Hatley	19	200	30	170	200	.....	.....	200	
Coaticook river: (*tributary of St. Francis*)									
539. Waterville	13	100	.....	.....	.....	.....	100	100	
540. Dixville	16	125	.....	.....	.....	.....	125	125	Used for lumber
540. "	.....	200	.....	.....	.....	.....	200	200	Lumber and grist mills
Tomifobia river:									
541. Rock Island	18	70	.....	.....	.....	.....	70	70	
541. Stanstead	.....	200	.....	200	200	.....	.....	200	
Baldwin creek: (*tributary of St. Francis*)									
542. Baldwin Mills	40	100	.....	.....	.....	.....	100	100	Used for lumber
Eaton river: (*tributary of St. Francis*)									
543. Westbury	24	250	.....	250	250	.....	.....	250	Electricity used in Westbury, Angus and Cookshire
544. Sawyerville	.....	230	.....	.....	.....	.....	230	230	Lumber and grist mills

DISTRICT No. IX—SOUTH SHORE OF THE ST. LAWRENCE RIVER ABOVE CHAUDIÈRE RIVER AND ST LAWRENCE RIVER ABOVE MONTREAL—*Continued*

Power Site	Available		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				REMARKS
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
Salmon river: (*tributary of St. Francis*)									
545. Scotstown	18	.....	.....	75	75	.....	.....	75	
545. "	12	.....	.....	.....	.....	.....	25	25	Machine shop
Yamaska river:									
546. St. Césaire	12	.....	.....	.....	.....	.....	135	135	Grist mill
547. Farnham	14	.....	.....	250	250	.....	.....	250	Electricity used in Farnham (pop. 3,500)
547. "	10	.....	.....	.....	.....	.....	300	300	Saw and grist mills
548. Freeport	.....	200	.....	.....	.....	.....	200	200	Dairy utensil factory
548. Cowansville	45	.....	.....	.....	.....	.....	100	100	Used for grist mill
549. Granby	16	.....	.....	175	175	.....	200	375	Electricity used in Granby (pop. 5,000)
549. "	35	.....	.....	.....	.....	.....	1,000	1,000	Rubber goods
David river: (*tributary of Yamaska*)									
550. St. David d'Yamaska	24	15	.....	.....	.....	.....	15	15	Grist mill
Black river: (*tributary of Yamaska*)									
551. Roxton Falls	20	400	.....	.....	.....	.....	400	400	Lumber and grist mills
Moose and Black rivers:									
552. Actonvale	9	200	.....	.....	.....	.....	200	200	Used for lumber
Brome lake:									
553. Brome	.....	300	.....	300	300	.....	.....	300	
Richelieu river:									
554. St. Ours	10	2,500	.....	.....	.....	.....	100	100	Grist mill; head much lower at floods

555.	Chambly	34	20,000	12,000	8,000	20,000			20,000	Electricity used in Montreal; power site owned by Montreal Light, Heat and Power Co.
	"	18	1,000					1,000	1,000	Woollen mill
556.	Chambly canal	25	200		200	200			200	Electricity used on canal
	7 m. below St. Johns	17	3,500							This power will shortly be available in connection with new Dominion Government work on the canal
Lacolle river: (*tributary of Richelieu*)										
557.	Lacolle	10	50					50	50	Used for lumber
Pike river: (*tributary of lake Champlain*)										
558.	Bedford	15	275					275	275	Axe and tool factory
	"		650					650	650	Used for grist mill and foundry
Orford lake: (*tributary of Missisquoi*)										
559.	Eastman	13	45					45	45	Box factory
Chateauguay river:										
560.	Ste. Martine	8	1,000					1,000	1,000	Lumber and grist mill
561.	Ormstown	12	1,000					400	400	" " " "
562.	Huntingdon	10	700					500	500	" " " "
St. Louis river:										
563.	Beauharnois	25	365					365	365	Grist mill
St. Lawrence river:										
564.	Coteau, Cedar and Cascades rapids	80	960,000							By damming whole river and obstructing navigation through rapids
	Note.—The above power has been partly utilized at the following places:									
	Soulanges canal, (near Cedars)	50		7,800	5,200	13,000			13,000	Electricity used in Montreal
	Soulanges canal	19			650				650	Electricity used to light canal and operate locks
565.	Valleyfield	10			135	135		7,000	7,135	Utilized by Montreal Cotton Co.
565A.	Beauharnois canal, St. Timothée	50				21,000			21,000	In construction, current to be used in Montreal

Power Site	Available		Electrical Energy Used, 1910 (Horse-power)		Developed (Horse-power)				REMARKS
	Head (in feet)	H.P.	Power	Light	Electrical Energy	Paper and Pulp	Other Industries	Total	
566. Lachine rapids	35	400,000	.....	.....	.....	.....	.....	.....	By damming whole river and obstructing navigation through rapids
Note.—The above power has been partly utilized at the following places:									
Lachine rapids	14	.....	7,800	5,200	13,000	.....	.....	13,000	Electricity used in Montreal
Côte St. Paul (Lachine canal)	8.5	.....	.....	310	310	.....	.....	310	Electricity used on canal
Côte St. Paul (Lachine canal)	8.5	.....	.....	.....	.....	.....	1,400	1,400	
Mill street (Lachine canal)	11	.....	.....	332	332	.....	.....	332	Electricity used on canal
Mill street (Lachine canal)	17	.....	.....	.....	.....	.....	}		
St. Gabriel locks (Lachine canal	8.5	.....	.....	.....	.....	.....	} 2,600	2,600	Used for flour mills, rolling mills, etc.

Note :

For No. 6, 567-582, see page 189 (District V)
„ „ 6, 583-619, „ pages 190-191 (District VI)
„ „ 6, 620-624, „ page 192 (District VII)

QUEBEC

Water-Powers for which only approximate figures are available

DISTRICT No. V—SAGUENAY BASIN

Power Site	Approx. Head in feet	Estimated H.P.	Remarks
Saguenay river:			
567. Grand Discharge	.....	375,000	
Shipshaw river:			
568. Caribou falls.....	15	1,000	
569. Galets falls	75	4,000	
570. Chute de l'Equerre.....	60	3,000	
Peribonka river:*			
571. Great fall, 14 m. from mouth	21	10,500	
571. Savanne fall, ½ m. up..	20	10,000	
572. Willie fall (just below Alex river)	20	10,000	
572. Bonhomme fall (½ m. above Alex river).....	20	9,600	
572. L'Islet fall (1½ m. above div. line bet. Taillon and Delisle tps.).....	10	4,800	
572. Devils falls (¾ m. up) ...	35	17,000	
573. McLeod falls (4 m. above Belly river)	40	19,000	
574. 5 m. above Manuan river..	100	26,000	
575. 20 m. above Manuan river	50	13,000	
Little Peribonka river:*			
576. Below White fall, 5 m. above mouth.....	20	630	
576. White fall	28	900	
Mistassini river;			
576a. 1st and 2nd falls.....	35	10,800	
576b. 33 m. from mouth.....	27	7,500	
576c. 180 m. " "	80	9,700	
Rat river:*			
577. First seven miles from mouth	30	650	
	40	880	
	60	1,30	
Ashwapmuchuan river:			
578. Bridge rapid, lot 20, R.I., Desmeules.....	20	6,000	Gauvin's report
578. Rapid, lot 15, R.I., Desmeules	6.5	2,000	Gauvin's report
578. St. Ange rapid	12	2,000	Langelier's report
579. Great Bear fall, 8 m. from St. Félicien bridge	80	100,000	Easily developed; Langelier's report
580. Petite Chute à l'Ours...	39	11,500	At mean low water
580. Rapide des Roches	30	30,000	Langelier's report
581. Pemoka and rapids above.	100	.....	" "
582. Chaudière falls, 75 m. from lake St. John	60	12,000	" "

*The amount of power on these rivers is based on a flow of 0.4 cubic feet per second per square mile of drainage area.

QUEBEC

DISTRICT No. VI.—NORTH SHORE OF THE RIVER ST. LAWRENCE BELOW THE SAGUENAY RIVER

	Power Site	Approx. Head in feet	Estimated H.P.	Remarks
Hamilton river:*				
583.	Muskrat fall	70	86,000†	
584.	Grand fall	302	120,000†	
	Grand fall (including 12 miles of rapids above and below)	760	300,000†	It would be extremely difficult to develop all of this power
Olomanoshibo river:*				
585.	2 m. from mouth	35	2,100	
586.	40 m. from mouth	30	1,300	
Washikuti river:*				
587.	Fall at mouth	47	740	
Muskwaro river:*				
588.	8 m. from mouth	15	800	
Kegashka river:*				
589.	2 m. from mouth	40	700	
	4 m. from mouth	30	500	
Natashkwan river:*				
590.	2 m. from mouth	100	17,500	
	4 m. from mouth	30	5,300	
591.	55 m. from mouth	30	4,000	
Agwanus river:*				
592.	4 m. from mouth	50	3,100	
593.	12 m. from mouth	40	2,500	
594.	20 m. from mouth	30	1,800	
	22 m. from mouth	25	1,300	
Nabisipi river:*				
596.	5 m. from mouth	70	2,000	
597.	22 m. from mouth	20	400	
Romaine river:*				
598.	At mouth	15	4,100	
599.	25 m. from mouth	80	21,000	
600.	165 m. from mouth	50	5,700	
St. John river:*				
601.	1st fall, 15 m. from mouth	155	12,300	
Manitou river:*				
602.	1st and 2nd falls, ½ m. from mouth	230	10,000	
Ste. Marguerite river:*				
603.	40 m. from mouth	40	3,300	

*The amount of power on these rivers is based on a flow of 0.4 cubic feet per second per square mile of drainage area.

†Dr. A. P. Low's estimate of a discharge of 50,000 cubic feet per second for the Hamilton river was made during a period of high water.

DISTRICT No. VI—NORTH SHORE OF THE RIVER ST. LAWRENCE BELOW THE SAGUENAY RIVER—*Continued*

	Power Site	Approx. Head in feet	Estimated H..P	Remarks
Pentecôte river:*				
604.	5 m. from mouth.	42	2,800	
	8 m. from mouth.	71	4,700	
Godbout river:*				
605.	6 m. from mouth	60	1,750	
606.	14 m. from mouth	32	900	
607.	18 m. from mouth	63	1,800	
Manikuagan river:*				
608.	12 m. from mouth.	110	88,000	
	12 m. from mouth (more recent)	86	68,800	
609.	22 m. from mouth	165	130,500	
610.	44 m. from mouth	115	82,900	(in four falls)
611.	124 m. from mouth	175	69,500	(succession of falls and rapids, 2 m. long. The H.P. given only assumes utilizing 100′ head)
612.	129 m. from mouth	20	13,000	Rapids, 1 m. long
Outarde river:*				
613.	80 m. from mouth	20	3,200	
614.	104 m. from mouth	40	5,400	
615.	110 m. from mouth	20	2,700	
Bersimis river:*				
616.	1st and 2nd falls, 45 m. from mouth	122	30,000	
616a.	Falls, 55 m. from mouth	20	5,000	
616b.	Falls, 65 m. from mouth	80	18,000	
617.	Foot of Natuakiminu lake	100	22,000	
Portneuf river:				
618.	1st fall, 4 m. from m'th	40	4,500	
619.	2nd fall, 6 m. from m'th	70	8,000	

* The amount of power on these rivers is based on a flow of 0.4 cubic feet per second per square mile of drainage area.

QUEBEC

DISTRICT No. VII.—SOUTH SHORE OF THE RIVER ST. LAWRENCE BELOW RIVER DU LOUP.

	Power Site	Approx. Head in feet	Estimated H.P.	Remarks
Magdalen river:*				
620.	Petit sault, 1¼ m. below Grande chute	130	6,680	At extreme low water
	Grande chute, 7½ m. from mouth	75	13,000	For mean low water
	660 yds. above Grande chute	140	.....	This combined with "Grande chute" would give 200 ft. head and an estimated development of 35,000 H.P. at mean low water, or 10,000 H.P. at extreme low water
621.	Part of Terrace Mountain rapid, 20 m. from mouth	283	10,000	Fall in 3¼ miles
622.	Part of Flat rapid, 26 m. from mouth	65	2,200	Fall in ¾ mile
623.	Clearwater rapid, 45 m. from mouth	58	920	
624.	Long rapid, 60 m. from mouth	383	.....	Fall in 5½ miles, near headwaters

* The amount of power on this river is based on proportion of the flow as estimated at Petit sault.

QUEBEC

DISTRICT No. X.—JAMES BAY SLOPE

	Power Site	Approx. Head in feet	Estimated H.P.	Remarks
	Whitefish river: (*tributary of lake Abitibi*)			
625.	Near N. T. Ry. line.	13	.....	These chutes are well adapted for use as small water-powers
625.	Near N. T. Ry. line.	15	.....	
625.	Near N. T. Ry. line.	30	.....	
	Harricanaw river:*			
626.	Fall, 37 m. from mouth.	30	22,000	
627.	Fall, 48 m. from mouth.	150	107,000	
628.	Fall, 70 m. from mouth	20	13,000	
629.	Fall, 80 m. from mouth.	20	9,700	
630.	Fall, 115 m. from mouth	48	20,000	
631.	30 m. below N. T. Ry.	26	5,000	
	Nottaway river:*			
632.	26 m. from mouth	20	22,000	
633.	31 m. from mouth	50	54,000	
634.	36 m. from mouth	25	27,000	
635.	45 m. from mouth	20	21,000	
636.	62 m. from mouth.	36	38,000	
	Bell river: (*tributary of Nottaway*)			
637.	Kiask fall.	30	8,400	
638.	Red Flower fall	30	7,100	
	Megiskan river:			
639.	Near mile 820, N.T.Ry.	67	17,000	
639.	Rapids below (to lake Shabogama)	110	.....	Represents total fall in 27 miles; only portions of this could be utilized
	Atik river:			
640.	Near mile 808, N.T.Ry.	70	1,700	
	Rupert river:*			
641.	Smoky Hill fall	50	33,000	
642.	Cat fall, 21 m. from mouth	74	47,500	
643.	Four falls, First fall.	30	18,800	
	,, ,, Second fall	50	31,400	
	,, ,, Third fall	75	47,000	
	,, ,, Fourth fall.	50	31,400	
644.	Oatmeal fall	18	11,000	
645.	80 m. from mouth	60	37,000	
	Eastmain river:*			
646.	Talking fall.	20	14,000	
647.	Island fall.	65	45,000	
648.	Coulston gorge, 47 m. from mouth	105	73,000	
648.	48 m. from mouth.	100	70,000	
649.	73 m. from mouth	100	66,000	
650.	140 m. from mouth	100	46,000	
651.	153 m. from mouth	60	27,000	

* The amount of power on these rivers is based on a flow of 0.4 cubic feet per second per square mile of drainage area.

CHAPTER V

Water-Powers of Nova Scotia

NOVA Scotia has no such large individual water-powers as are to be found in some of the other provinces of Canada having watersheds of large area. Nevertheless, they should not be considered as too small to merit serious attention. As a matter of fact, they are particularly well-suited to some of the economic requirements of the Province, and, what is more, they are well distributed. If care be exercised in their development and conservation, they will become an increasingly valuable asset. In the following treatment, it is desired to emphasize the value of the waters of the Province as a resource necessary for domestic and municipal water supply, and for the development of power for mining, lumbering and other industrial purposes.

Some misapprehensions which have gained currency should be cleared away at the outset. The statement has been made that Nova Scotia has a surplus of inland waters, and from this it has been inferred that the conservation of this resource was therefore not a matter of pressing concern. The fact was lost sight of, that, in a large portion of the Province, the depth of the soil is not great and, instead of the water being stored as underground water, it lies exposed on the surface of the earth.

In the second place, it has been stated that, since the water-powers are largely under private control, it is not worth while expending effort on their conservation because the provincial revenue would not be directly increased thereby. This is a mistaken line of reasoning. One might as well say that, since the farms of the Province are all privately owned, the Government would not be wise in seeking to improve agriculture. The point to notice is that Government exists for the good of the people, not merely for the purpose of amassing a state treasure. Though most of the water-powers of Nova Scotia have passed from the ownership of the Crown, nevertheless, the conservation and intelligent use of the waters are matters of public concern, both from the point of view of power for industrial purposes, as well as from the standpoint of municipal and domestic water supply.

Law Relating to Waters

The present situation as regards water-powers can be intelligently understood only after the historical evolution of the legislation of the Province respecting Crown lands, and water rights and privileges connected therewith, is known.

In the early days large tracts of land were granted, chiefly for purposes of inducing colonization, to New Englanders, especially those who took

part in the capture of Annapolis and Louisburg, and also to the United Empire Loyalists. For example, in 1765, a grant in Guysboro county of 150,000 acres, was made to James Lyon and others. Another grant made in 1769, in Halifax county, comprised 100,000 acres, and an area of equal amount was conveyed in the Mira grant, in Cape Breton, in 1787. Thus, in large grants such as these, a considerable portion of the lands, and the water-powers situated on them, passed from the possession of the Crown.

Up to 1899, the Crown lands were granted to applicants at a nominal price, subject to certain conditions as to settlement. From 1899 to 1910 *grants* were made of lands for agricultural purposes, while for lumbering purposes *leases* were given.

It has been the policy in making grants of land to reserve the minerals, but, previous to the enactment of the Crown Lands Act of 1910, no reservations had been made of the waters, of the beds of rivers, nor of lakes comprised within the land grants. The significance of this, in so far as water resources are concerned, will be realized when it is known that about ninety per cent. of the Crown lands have been granted, 1,500,000 acres having been disposed of since 1867. The estimated amount ungranted in 1909 was 1,446,160 acres, or approximately ten per cent. of the area of the Province. Thus, in consequence of these grants, large areas of inland waters became removed from the possession and immediate control of the Government of the Province.

Provision has been made by statute for the conveying of timber and lumber on rivers and streams, and for the removal of obstructions from the rivers and streams, subject to the rights of riparian owners.*

Apart from the Common Law respecting the rights of riparian proprietors, there is no restriction by statute against the pollution of the inland waters.

With one exception—the Mersey Hydraulic Co.,† incorporated, 1902—no grants, or leases, have been made for water-power or other water privileges. The Mersey Hydraulic Co., was empowered to dam the Mersey (Liverpool) river, for the purpose of storing water, generating power and conveying lumber, the rates for the use of such water to be subject to the approval of the Lieutenant-Governor in Council.

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* See Act, *Of the Conveying of Timber and Lumber on Rivers, and the Removal of Obstructions Therefrom*, Revised Statutes of Nova Scotia, 1900, chap. 95.

† Nova Scotia Acts of 1902, chap. 138.

FRESHET, UPPER PULP MILL DAM, LIVERPOOL RIVER, NOVA SCOTIA, MARCH 9, 1910

Crown Lands Act of 1910

Under the Crown Lands Act of 1910* no grants are made of tracts exceeding 150 acres in area, and all grants are made under conditions requiring settlement and cultivation. No *leases* for lumbering purposes are given; *licenses to cut* timber are given instead. Leases of Crown Lands and lands covered with water, and rights of flowage may be given for the purpose of storing water, for developing water-power, for mining, and for conveying timber. Furthermore, no existing lease of timber lands confers any exclusive right to waters or lands covered with water.†

The Government of Nova Scotia may yet find it in the interest of the Province to undertake competent and systematic supervision of the Provincial inland waters. The subjects of diversions of water, stream pollution, fish-ways, the preservation of scenic beauty, log driving and the development of water-powers, are matters well worthy of attention.

The Maritime Provinces may learn from such instances, as the pollution of Toronto harbour, the Great Lakes system and the Ottawa river, and from what pollution by summer travel has done for some of the Muskoka waters, that there is need to safeguard their own inland waters against similar pollution.

Those persons upon whom it devolves to provide for domestic and municipal water supplies should have their hands strengthened in every reasonable endeavour they make to safeguard waters which are now, or which, in the future, may become, sources of supply for the growing cities, towns and villages of the Province.

Pollution by Industrial Wastes

No effort should be spared to prevent the pollution of waters by the improper disposal of domestic sewage and industrial wastes. Special precautions must be exercised to insure that industrial wastes are not permitted to foul inland waters and harbours. The deposit of saw-dust, mill refuse and crusher sand in harbours and inland waters of Nova Scotia is a fruitful source of pollution. Apart from its effects upon navigation, one of the detrimental effects is to smother the growth of foods for various kinds of fish, and other forms of aquatic life.

Commenting upon the effects of pollution by industrial wastes, H. A. Russell, District Engineer for the Department of Public Works, Halifax, says :

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* *An Act to amend and Consolidate the Acts Relating to Crown Lands,* 10 Ed. VII, chap. 4 (Nova Scotia), passed April 22, 1910. See also, Revised Statutes of Nova Scotia, 1900, chap. 24. *The Marsh Act* is R.S. 1900, chap. 66; *The Ditches and Water Courses Act,* is R.S. 1900, chap. 67. See also, *Timber Regulations Under the Crown Lands Act,* chapter 4, Acts of 1910; (14 pp. pamphlet).

† See Crown Lands Act (Nova Scotia), 10 Ed. VII, chap. 4. sec. 34-36.

"At Moser River, Sheet Harbour, Tangier, Ship Harbour, Musquodoboit Harbour and Margaret Bay, irreparable damage has already resulted from these causes, while at Salmon River (Beaver Harbour) an excellent little harbour has been almost destroyed by deposits of crusher sand. At Sheet Harbour there are some millions of tons of saw-dust piled about the banks of the river at its mouth, from which the erosion must be very great. Large quantities of this are no doubt being carried out into the harbour with every freshet and every rain.

"Though a law prohibiting the dumping of saw-dust in harbours and streams is now being partially enforced, considerable carelessness is, nevertheless, apparent, especially in the case of smaller mills situated furthest from the shore, and even in some cases by large mills, whose interests would be better secured by more carefully guarding against the destruction of harbours which to them are of great value. Proper appreciation of the value of navigable harbours appears to be lacking in a large majority of mill and mine owners."

It is, indeed, anomalous to find mill operators casting saw-dust or other refuse from their mills into a river, or harbour, while, at the same time, public money is being expended upon dredging operations in order to remove such industrial waste deposits, and thereby afford an entrance for shipping.

Forests and Inland Waters

Quite apart from the general question of the effect of deforestation on run-off, there are several consequences following the denuding of land of timber which deserve some attention.

Incidentally referring to the effects of deforestation, Road Commissioner Hiram Donkin, in his Report for 1909, states that

"It is of the utmost importance in the construction of small bridges that, in future, ample allowance be made in the span of the structures, to provide against conditions arising from the fact that as the country becomes cleared up, or denuded of timber, the rain-fall must of necessity flow to the streams more quickly and the freshets become more severe."

while in the same report, Assistant Commissioner James W. Mackenzie writes, that

"It seems to have been the custom for years as wood became scarce, to narrow up and confine the streams in smaller vents. If it is a fact that the clearing up of the country is the cause of the water running off suddenly in case of heavy downfalls, our bridges must be enlarged to carry the increased streams, and this has been my experience during the last twenty years."

LIVERPOOL RIVER AT LOW WATER, SHOWING BOULDER-STREWN BED

With regard to the character of the damage that may result from careless lumbering, Mr. Mackenzie says,

> "The most destructive summer freshet experienced in the counties of Antigonish and Pictou for the last twenty years, was the freshet of August 2nd, 1908. Some forty-six bridges in Antigonish county and fifty-six in Pictou were carried out, and in some sections every structure in wood was cleaned away. I took particular notice that where the lumber trimmings had been thrown into the stream, the destruction was the greatest."

and, in a letter dealing with these matters he states, that

> "Wherever the streams passed through cultivated lands, the bridges escaped destruction, but where they passed through wooded lands, culled over by lumbermen, boughs, trimmings of trees, brush and sticks of every description, logs, etc., were carried down, forming jams at every turn, and carrying away all the bridges."

Debris of this kind is a serious menace not only to bridges and public highways, but also to water-power developments and to log driving.

Fish-ways and Dams

On some of the principal rivers of Nova Scotia, there are power and other dams which have no fish-ways. The Fisheries Act* explicitly provides that fish-ways shall be built wherever the Minister of Marine and Fisheries determines they are necessary. It says:

> 1. "Every dam, slide, or other obstruction across or in any stream where the Minister determines it to be necessary for the public interest that a fish-pass should exist, shall be provided by the owner or occupier with a durable and efficient fish-way, which shall be maintained in practical and effective condition, in such place and of such form and capacity as will admit of passage of fish through the same.
>
> 2. "The place, form and capacity of the fish-way may be prescribed by any fishery officer by notice in writing.
>
> 3. "Fish-ways shall be kept open and unobstructed and shall be supplied with a sufficient quantity of water to fulfil the purposes of this enactment, during such times as are required by any fishery officer."

The absence of suitable and efficient fish-ways, properly maintained, is a decided loss to the fisheries of the Province, especially in the case of salmon and gaspereau, a branch of industry which results in revenue to the people of Nova Scotia of about $150,000 per year. The loss may

* R.S. Canada, 1906, chap. 45.

also be viewed from the standpoint of the tourist traffic: Baedeker says that "every salmon caught by tourists in the Maritime Provinces involves an expenditure in the country of from $25 to $35."

Suitable fish-ways require comparatively little water—the amount discharged by an opening about twenty inches wide by about twelve inches deep under a head of about twelve inches. The periods during which the fish-ways should be kept full vary somewhat with the habits of the fish, but, in Nova Scotia, a representative season may be taken as from April 1st to July 1st, and, again, from Sept. 15th to December 1st. Thus the fish-way season, not coinciding with the low-water season, is one which conflicts comparatively little with power development.

Log Driving and Boulders

The beds of many rivers are strewn with large boulders, and, in log-driving seasons, it becomes necessary to flood these boulders so that the logs may pass over them. To flood these river bottoms often entails great loss of water, which might otherwise be stored, and be made available for use for power, and other purposes during the low-water seasons. In some instances it may be possible for logging, water-power, or other interests to co-operate in sharing the expenses incident to the improvement of river-beds.

Inland Waters Attract Tourists

The value of the inland waters of Nova Scotia, and New Brunswick, as an attraction for tourists is well known. Care should be exercised to conserve the scenic and sporting attractions afforded by these waters. If water is to be stored in lakes and rivers for the purpose of augmenting the water supply for power, or for log-driving purposes, it should be ascertained what the effect will be upon the tourist traffic. For example, if the surface of a lake is to be raised, say, eight or ten feet above its accustomed level, the water will, in the majority of instances, destroy all the shore line vegetation. Pleasure seekers are not attracted by a lake, or river, fringed with five or ten feet of dead and whitened shrubs. In some cases of this kind in Ontario, the Government has had to intervene and prevent private interests from so raising the levels of certain lakes as to spoil their scenic beauty.

Diversions of Waters

In some instances portions of the waters of one watershed may, more or less readily, be diverted to another watershed. Government approval and sanction should be had to make particular diversions of waters before any such works are permitted.

"The Long Wharf"

A study of the map of Nova Scotia reveals the fact, that the majority of the large rivers empty along the southerly coast of the Province. This coast is famous for its many excellent harbours, and has been referred to as the "Long Wharf of America." It is note-

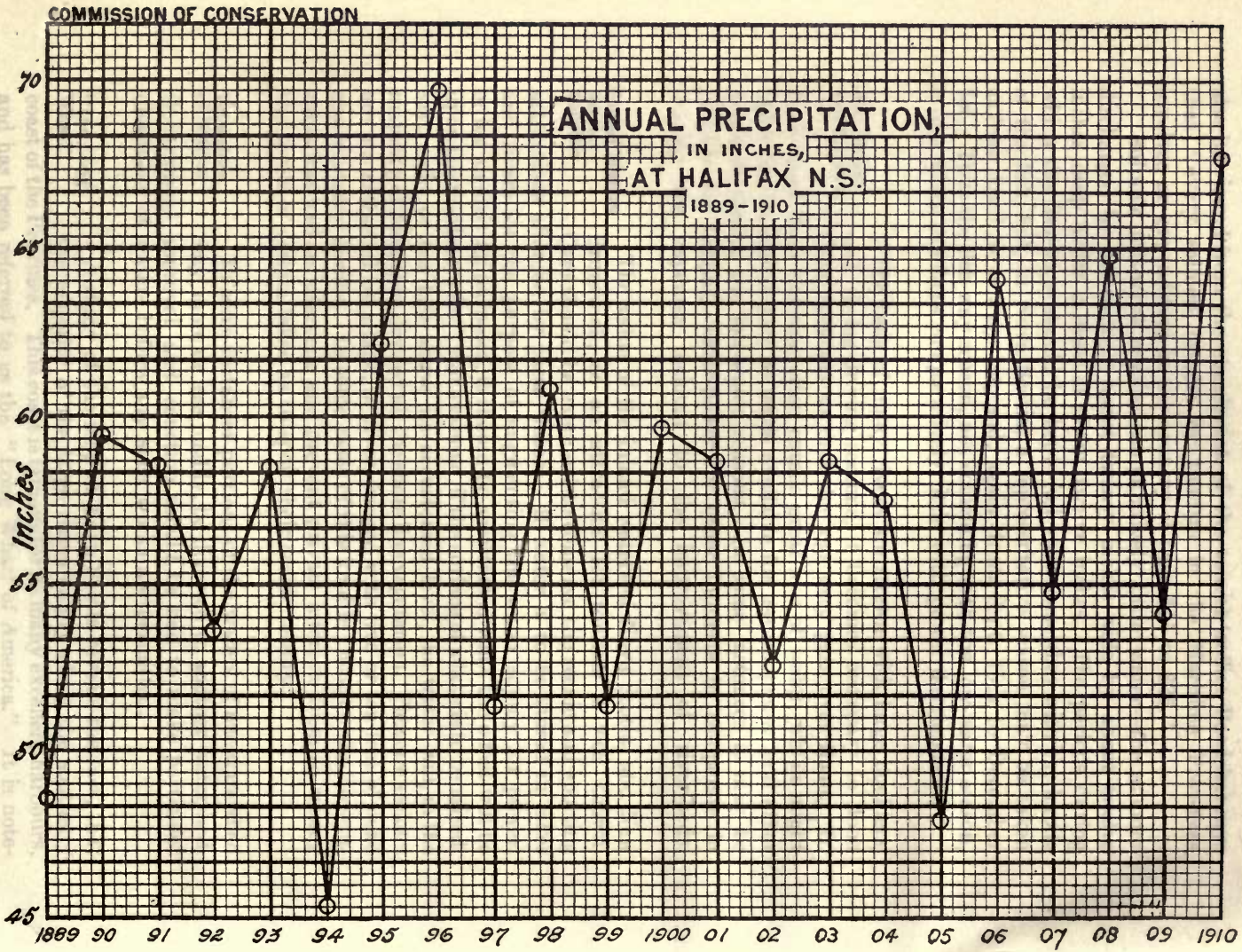
ANNUAL PRECIPITATION

IN INCHES

AT HALIFAX N.S.

1885 - 1910

Inches


COMMISSION OF CONSERVATION
ANNUAL PRECIPITATION,
IN INCHES,
AT HALIFAX N.S.
1889-1910
Inches
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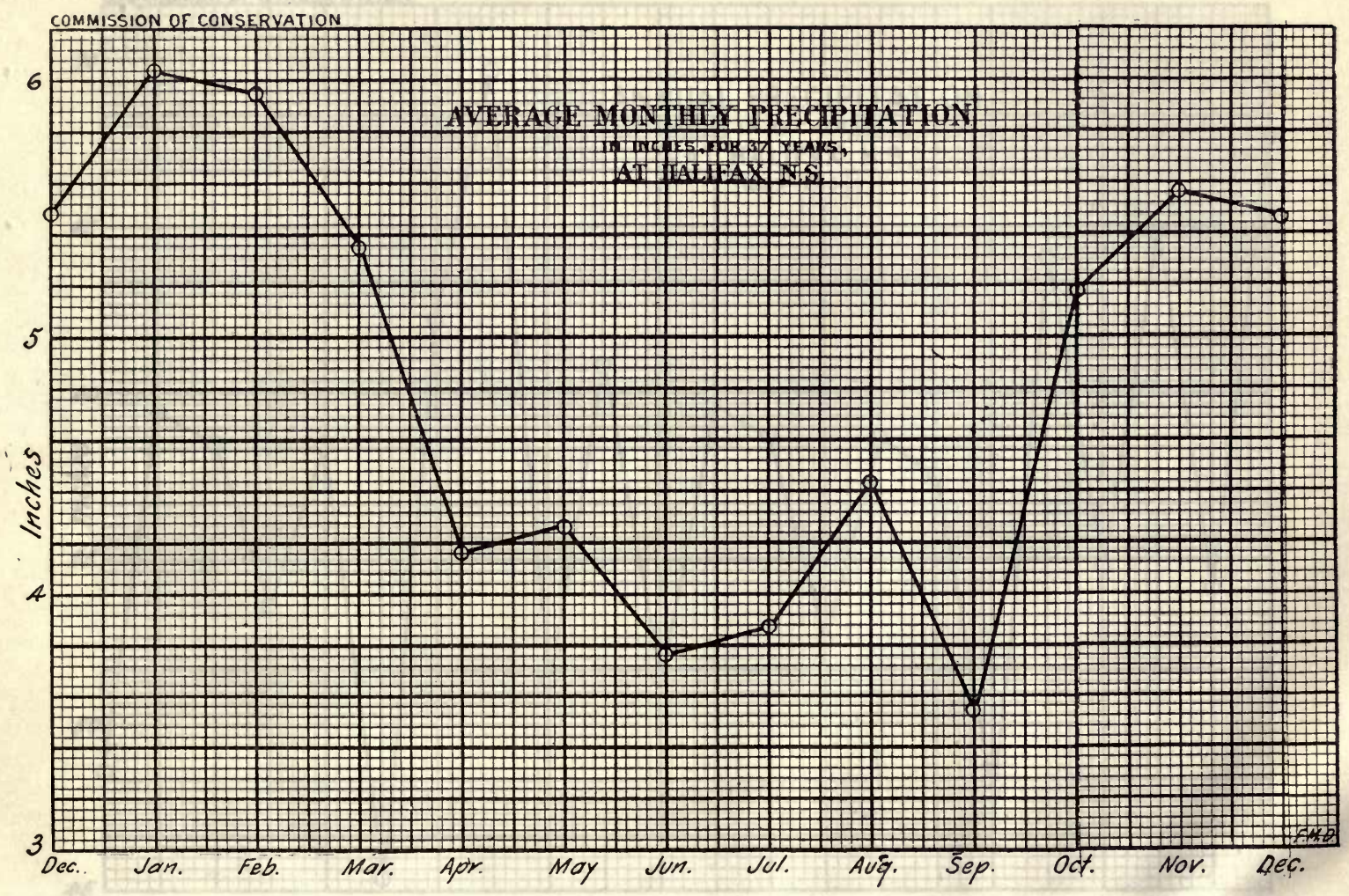
COMMISSION OF CONSERVATION
AVERAGE MONTHLY PRECIPITATION
IN INCHES, FOR 37 YEARS,
AT HALIFAX N.S.
Inches
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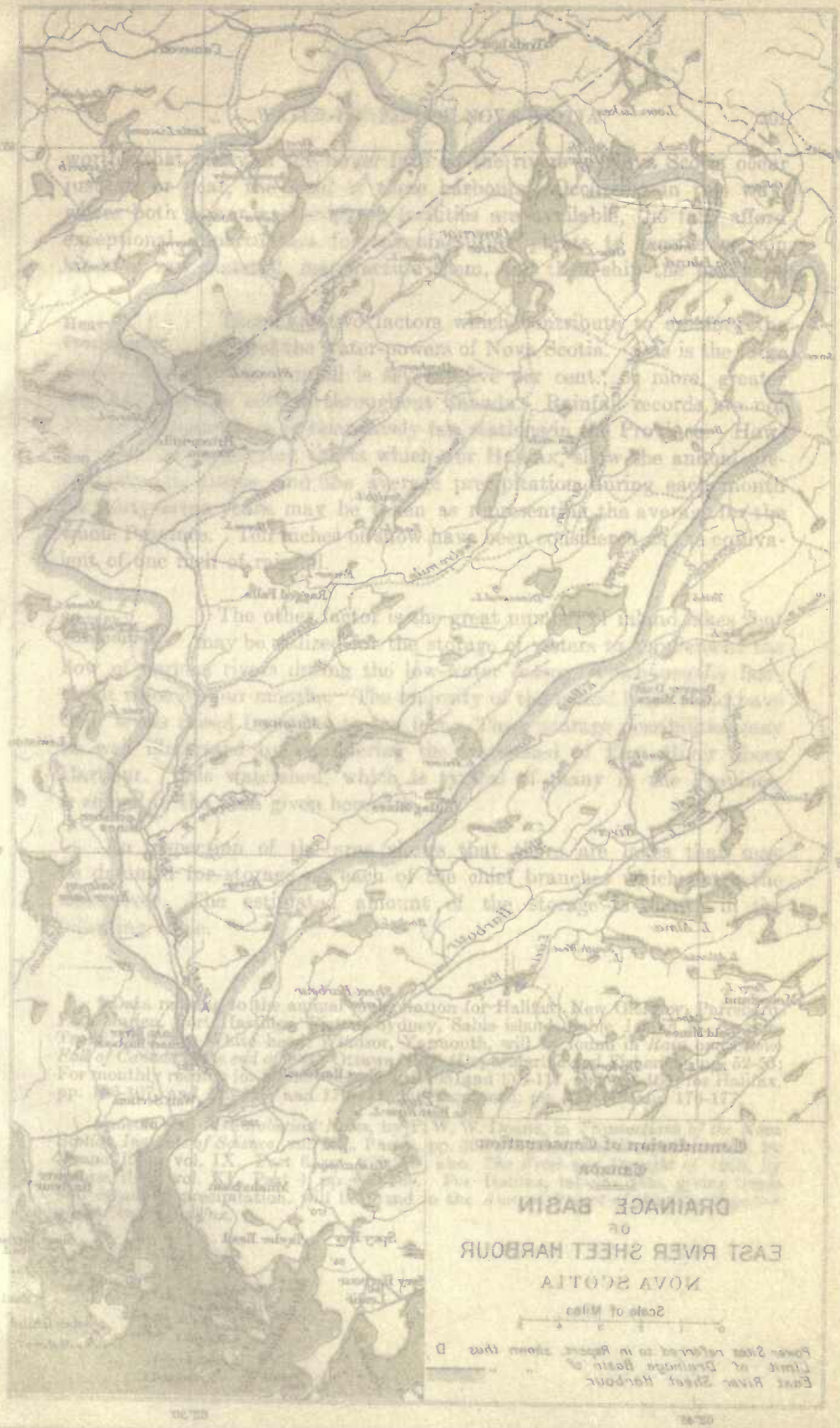

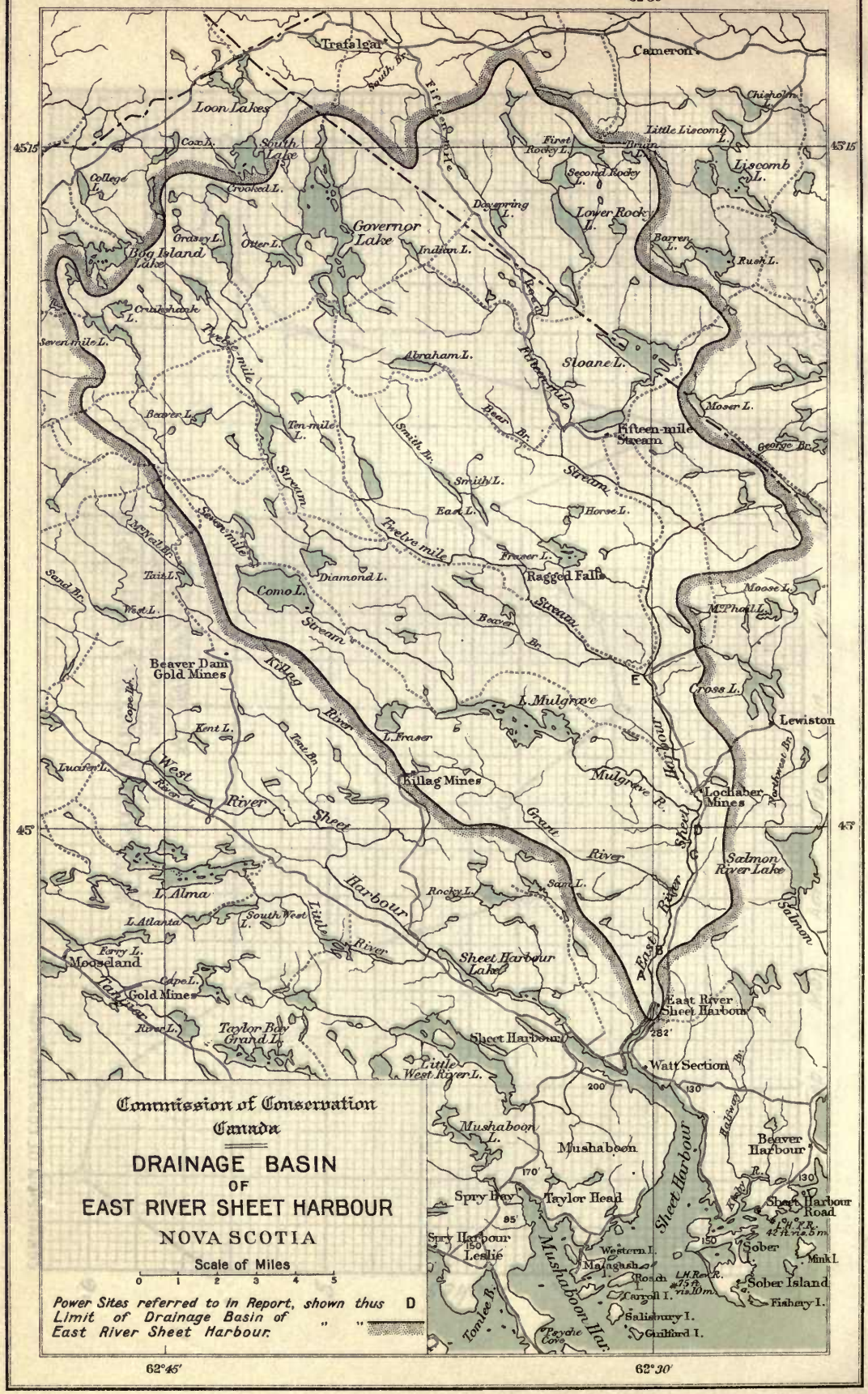
62°45′
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Commission of Conservation
Canada
DRAINAGE BASIN
OF
EAST RIVER SHEET HARBOUR
NOVA SCOTIA
Scale of Miles
0 1 2 3 4 5
Power Sites referred to in Report, shown thus D
Limit of Drainage Basin of " "
East River Sheet Harbour.
Trafalgar
Cameron
Loon Lakes
South Lake
Governor Lake
Bog Island Lake
Fifteen-mile Stream
Sloane L.
Ragged Falls
Killag River
Beaver Dam Gold Mines
Killag Mines
L. Mulgrave
Mulgrave R.
Lochaber Mines
Lewiston
Salmon River Lake
Salmon
East River Sheet Harbour
Sheet Harbour
Watt Section
Sheet Harbour Lake
Mooseland
Gold Mines
Taylor Bay Grand L.
L. Alma
L. Atlanta
Mushaboon
Mushaboon Har.
Taylor Head
Spry Bay
Spry Harbour
Leslie
Western I.
Malagash I.
Rosh I.
Carroll I.
Salisbury I.
Guilford I.
Psyche Cove
Tomlee B.
Beaver Harbour
Sheet Harbour Road
Sober I.
Sober Island
Fishery I.
Mink I.
Seven-mile L.
Beaver L.
Ten-mile L.
Smith L.
East L.
Horse L.
Fraser L.
Diamond L.
Como L.
West L.
Tait L.
Kent L.
Lucifer L.
L. Fraser
Rocky L.
Sam L.
Grant River
Little West River L.
Little River
West River
Sheet Harbour
Cape L.
Ferry L.
Tanner River L.
Moser L.
Moose L.
Cross L.
Liscomb L.
Little Liscomb L.
Lower Rocky L.
Second Rocky L.
First Rocky L.
Indian L.
Abraham L.
Barren L.
Rush L.
Crooked L.
Grassy L.
Otter L.
Cox L.
College L.
Davspring L.
Chisholm
Bear Br.
Smith Br.
Beaver Br.
George Br.
Sand Br.
Tent Br.
Cape Br.
Northwest Br.
Railway Br.
Kisby R.
Twelve-mile Stream
Seven-mile Stream
Fifteen-mile Stream
Harbour
Sheet Harbour
East River
Salmon
A
B
D
E
282′
200
130
170′
150
85′
L.H.R.R. 42 ft. vis. 5 m.
L.H.Rev.R. 75 ft. vis. 10 m.

worthy that many of the larger falls on the rivers of Nova Scotia occur just at, or near, the head of these harbours. Occurring in this way, where both power and shipping facilities are available, the falls afford exceptional opportunities for manufacturing plants to receive certain kinds of raw material, manufacture them, and then ship the products.

Heavy Precipitation

There are two factors which contribute to enhance the value of the water-powers of Nova Scotia. One is the large precipitation.* The rainfall is seventy-five per cent., or more, greater than the average rainfall throughout Canada. Rainfall records are not available except for a comparatively few stations in the Province. However, the accompanying charts which, for Halifax, show the annual precipitation in inches, and the average precipitation during each month for thirty-seven years, may be taken as representing the average for the whole Province. Ten inches of snow have been considered as the equivalent of one inch of rainfall.

Storage Possibilities

The other factor is the great number of inland lakes that may be utilized for the storage of waters to supplement the flow of various rivers during the low-water season, which usually lasts about three or four months. The majority of the inland lakes could have their levels raised from five to ten feet. These storage possibilities may be well illustrated by considering the watershed of East River Sheet Harbour. This watershed, which is typical of many in the Province, is shown in the plan given herewith.

An inspection of the area shows that there are lakes that may be dammed for storage on each of the chief branches which enter the main river. The estimated amount of the storage is shown in the following table.

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* Data relating to the annual precipitation for Halifax, New Glasgow, Parrsboro, Port Morien, Port Hastings, Pictou, Sydney, Sable island, Sable Island M. Station, Truro, Wolfville, White head, Windsor, Yarmouth, will be found in *Rain and Snow-Fall of Canada to the end of* 1902, Ottawa, 1906 (Dept. Marine and Fisheries), pp. 52-53; For monthly records for Sydney see pp. 104-105, and 116-117, and 168-169; for Halifax, pp. 106-107, and 118-119, and 170-171; for Yarmouth, pp. 112-113 and 176-177.

Consult also *Meteorological Notes*, by F. W. W. Doane, in *Transactions of the Nova Scotian Institute of Science;* vol. XI., Part 3, pp. 361-372; also, *The Rainfall in 1896*, by Doane, ibid., vol. IX., Part 6, pp. 279-290; also, *The Frost and Drought of 1905*, by Doane, ibid., vol. XI., Part 4, pp. 623-639. For Halifax, tabular data, giving totals and details of precipitation, will be found in the *Annual Report of the City Engineer of the City of Halifax.*

NOVA SCOTIA

WATER STORAGE POSSIBILITIES

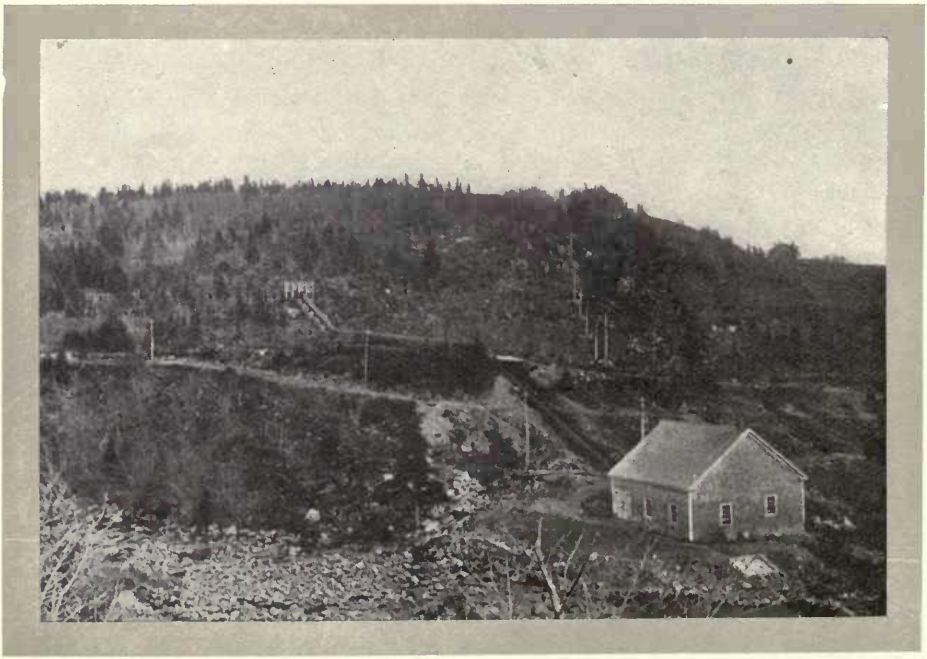
Possible storage basin	Area (in square miles)	Estimated depth of storage (in feet)	Equivalent storage (in square-mile-feet)
Lake Mulgrave	1.5	9	13.50
Lake Fraser	.43	6	2.58
Como lake	1.3	7	9.10
Seven-mile lake	.7	6	4.20
Fraser lake	.30	5	1.50
Ten-mile lake	.45	10	4.50
Above Ten-mile lake	.30	6	1.80
Governor lake	2.63	20	52.60
Flowages	.30	5	1.50
Sloan lake	1.0	5	5.00
Bay Spring lake	.3	5	1.50
Lower Rocky lake	.75	5	3.75
Flowages	.3	5	1.50
Total	10.26		103.03

The equivalent of the estimated storage is 103.03 square miles of water one foot deep. Assuming an allowance for evaporation of 15 inches over 10.26 square miles, there would be left 90.21 square mile feet. Now one square mile of water one foot deep is sufficient to maintain a flow of about .88 cubic feet of water per second for one year. Hence, 90.21 square miles of water should maintain a flow of about 80 cubic feet per second for one year. This is equivalent to 320 cubic feet per second for three months, or 640 cubic feet per second for three months for daily run of twelve hours. It is not profitable, in the absence of essential data, to speculate as to how power obtained from these stored waters might be distributed throughout low-water periods, nor as to what the resulting minimum power might be. However, if the low-water flow without storage should drop, say for three months, to 50 cubic feet per second, storage might be utilized to increase this several fold. It should be remembered that, where the storage sites are scattered, several dams will be required. The cost of construction and operation of such may, in some instances, more than offset any advantages to be derived from the use of the stored waters. Each case must be decided upon its own merits.

Municipal Power Plants

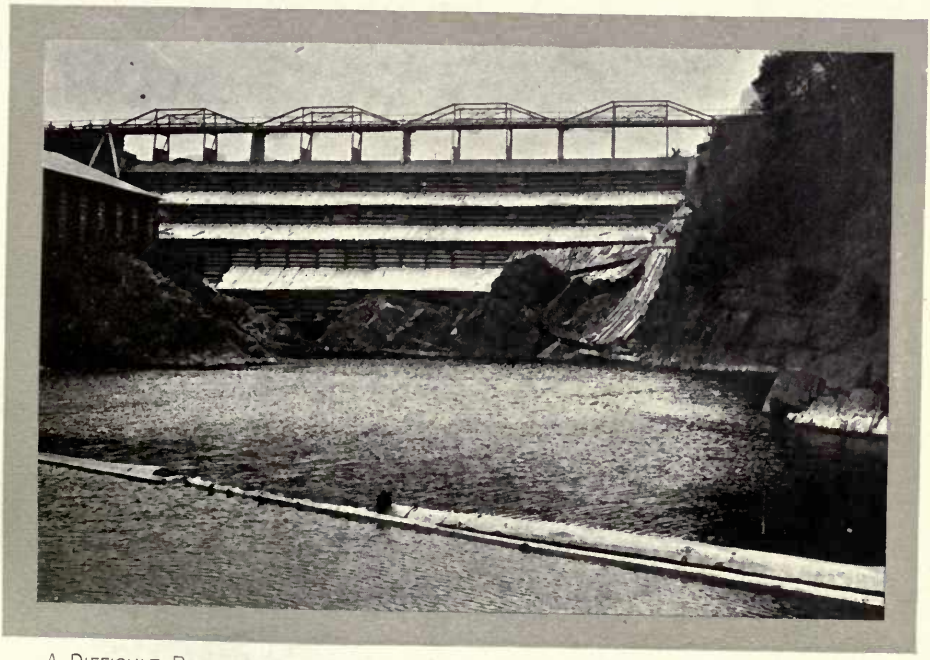
Municipalities in Nova Scotia might profitably, follow the example of some of the towns of the Province, and secure control of any suitable nearby water-power, the development of which would provide hydro-electric light and power.

SHELBURNE MUNICIPAL HYDRO-ELECTRIC PLANT, ON THE MEDWAY RIVER, NOVA SCOTIA



A MINE POWER HOUSE AT ISAAC HARBOUR, NOVA SCOTIA, WHICH UTILIZES SMALL WATERSHED WITH HIGH HEAD

Nova Scotia—A Typical Log-Driving Dam. Note the Dead Trees, the Result of Flooded Banks



A Difficult Problem in Fishways—Pulp Mill Dam, Sissibou River, Nova Scotia

The following towns are now lighted from hydro-electric plants, the majority of which are municipally owned: Bridgewater, Lunenburg, Mahone, Liverpool, Shelburne, Annapolis, Bear River and Bridgetown. Other towns have proposed developments under consideration. Many towns operate steam-driven electric plants which pay from $2 to over $5 per ton for their coal.

Power for Manufacturing

Nova Scotia has iron and coal, advantageously situated relatively, the one to the other, so that huge centralized industries could be founded upon the exploitation of these resources. It is, however, not with regard to their relation to large centralized industries that the water-powers of Nova Scotia have their importance, but in their relationship to smaller industries to which cheap power and water are of vital importance.

In passing through the less travelled portions of the Province one is struck with the bad effects which have resulted from shipping timber, say, as deals and dimension timber, and other raw material, out of the country, in forms and conditions requiring but a minimum of manufacturing. This means non-utilization of available water-powers and a decided loss to the labouring interests of the Province.

An effort is being made by the Factory Inspection Branch of the Provincial Department of Public Works and Mines to collect data respecting power plants installed in manufacturing establishments. Although this work is only in the initial stages, the data collected in 1910 are cited to show the magnitude of certain branches of manufacturing and their general distribution throughout the Province.

Power, in the counties named in the table below, is installed for manufacturing purposes approximately as follows:*

Industry	Horse-Power
Pulp and paper mills. (The majority of these plants are usually operated for only eight or nine months in the year.)	11,000
Saw and planing mills. (The majority of these plants are usually operated for only six or seven months in the year.)	10,200
Wood-working plants	5,000
Metal industries	9,300

* The data given below must not be construed as an accurate statement of engineering facts, and, further, it must be recognized that the figures are not given to show the totality of the horse-power used. At the time these figures were compiled, the data had not been gathered in the counties of Antigonish, Guysboro, Richmond, Inverness and Victoria and some of the counties mentioned in the list have not, as yet, been fully canvassed. No mining nor electric light and power plants, nor laundries, are included. Data for the large centralized steel and coal industries located at Sydney, New Glasgow and Springhill, which, of course, use steam power, are not here included,

Car building	2,800
Food products	4,700
Fabrics	1,400
Miscellaneous, including tanneries, boots and shoes, cement, brick and tile, plaster, etc.	5,100

Some idea respecting the number of manufacturing plants, the number of persons employed therein, and the power used in the operation of the plants, may be obtained from the following table.

NOVA SCOTIA

POWER USED IN CERTAIN COUNTIES

County	Number of Establishments visited	Number of Employees	Horse-Power Installed*			
			Steam	Electric	Water	Total
Halifax	116	4026	8038	622	1253	9913
Lunenburg	29	432	730	.....	1498	2228
Queens	29	561	370	.....	7185	7555
Shelburne	10	125	290	.....	140	430
Yarmouth	16	752	965	31	.....	996
Digby	16	342	555	.....	2876	3431
Annapolis	14	472	1453	3	11	1467
Kings	35	383	1142	.....	197	1339
Hants	56	1002	3350	.....	1867	5217
Colchester	22	840	1303	178	110	1591
Cumberland	55	3034	5762	253	120	6135
Pictou	44	2102	4830	565	15	5410
Cape Breton	26	4465	3095	917	.....	4012
Totals	468	15536	31883	2569	15272	49724

Power for Mining Operations

The Department of Mines of Nova Scotia is of the opinion that some of the gold and other mines of the Province would be much benefited if small water-powers were developed to supply hydro-electric power for operation of the plants. The transportation charges on coal to many mines makes the cost of steam power excessive, and this excess of cost, in comparison with hydro-electric power, becomes the more pronounced when 24-hour operation of the mine is taken into account. The cost of power from coal for 24 hours is nearly double the cost for 12 hours; whereas, for 24-hour hydro-electric power the cost may be but a relatively small fraction over the cost of the same amount of power for 12 hours. In the majority of instances the user of power has no sufficiently correct idea of what his power costs him, and he would be much surprised to learn by how much the actual cost exceeds

* It will be noticed that the power is that *installed* and it is not, therefore, necessarily all in continuous use.

SAW MILL ON THE ST. CROIX RIVER, NOVA SCOTIA, RUN BY WATER-POWER THE YEAR ROUND

Photo by Cunningham.

SUITABLE FOR A POWER-DAM SITE, ECUMSECUM RIVER, NOVA SCOTIA

his estimate. In the case of the gold mining companies, enquiry shows that they are paying for fuel delivered about $5 per ton for coal, and from $3 to $4 per cord for wood.

Water-Power with Steam Plant Auxiliary

There are many water-powers which are not large enough to satisfy certain power requirements, and, in consequence of their limitations, are frequently passed over as not worthy of development. Careful investigation will, however, often show that these may be profitably developed to work in co-operation with auxiliary plants operated by steam or other prime agencies. In such cases it is essential that the best engineering talent be secured to obtain the most economic results.

General Character of some Nova Scotia Rivers

The Liverpool river,* commercially the most important river in the Province, has exceptional storage facilities in its head-water lakes. While some falls have been developed, there is still a large total fall in the river which has not yet been utilized. Somewhat corresponding remarks will also apply to the Gaspereau river.

Portions of some of the rivers, as, for example, parts of the St. Croix river, run between well defined rocky banks. Along such rivers, dams might be built between the banks, and water-powers thereby created, although water-power possibilities of this class are not apparent to the casual observer.

Sometimes, as in a notable instance upon the Ecumsecum river, a river will narrow up into a gorge-like passageway, affording a splendid dam site. This would result in holding the waters back to form a large storage reservoir.

There are rivers like the Tusket, Musquodoboit, and St. Mary, with quite a marked fall in portions of their ourses, but with low banks affording no possible sites for dams. Again, in the case of such rivers, it sometimes happens that, even though dam sites are found, raising the water would overflow valuable agricultural land, and the damage thus incurred might more than off-set the advantages resulting from such development.

Rivers like the Annapolis, the Avon, and the Shubenacadie are tidal for many miles up from their mouths, and, where falls may occur near the headwaters, the conditions are frequently unfavourable for power developments, partly on account of the small watershed area, and partly on account of the liability of the rivers to 'silt up' above the dams.

In Pictou, Cumberland and Antigonish counties the country is flat and the lower portions of the rivers have no falls. The same is true in a large portion of Cape Breton—although there are some high falls on the

* See *Water-Powers in the Mersey River, N.S.*, by W. G. Yorston, in *Proceedings and Transactions of the Nova Scotian Institute of Science;* vol. XI., Part 4, pp. 651-666.

Indian brook, the North river and other coastal streams. At the place where the view is taken a tape line dropped from the top of the bank to the water showed precipitious rocky banks nearly 60 feet in height. At such situations dams may be placed and, relatively large reservoirs created to make power available for portions of the year.

Meterings of Rivers

In the fall of 1910, the quantity of water flowing in some of the rivers of Nova Scotia was ascertained by metering the flow. Deductions from such meterings are given in the following table. The column headed "Discharge in cubic feet per second per square mile" shows how small the run-offs may become on even the larger rivers of the Province. It must be understood that no comparisons between the run-off from the various rivers mentioned, could be based upon the figures given in the table, because it has not been possible to make compensation for local causes affecting the run-off, such, for example, as recent rainfall, the temporary storing of waters, etc. The data, however, emphasize the need for great caution in order to keep proposed developments within conservative limits.

Sources and Character of Tabular Data.

In the latter part of 1910, a reconnaissance survey was made of many of the water-powers of the Province, a large part of the information being collected by the Nova Scotia engineers of the Department of Public Works, Canada.* The results of the survey are given in the tables which follow. Many small powers are included because some of them have already been advantageously developed, and also because two or more heads may frequently be combined into one development.

The column headed "Approximate area of watershed in square miles" gives the approximate areas, as measured from the best available maps.† Later maps of Nova Scotia are in process of publication, and such will permit more accurate measurements of watershed areas to be made.

The column headed "Approximate head in feet," in the majority of instances, gives the natural head. Sometimes however, the possible head, and sometimes the developed head, are given. The statements made under the column of "Remarks" must be considered in connection with the column relating to head. These heads were generally ascertained by

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*Acknowledgment is gratefully made to the following District Engineers of the Department of Public Works, Canada, for supplying data:—H. A. Russell, C. E. W. Dodwell, E. G. Millidge and T. Locke; also to R. H. Cooper, L. Cunningham, T. M. Schenk and N. C. Ralston; to R. McColl, Provincial Engineer and to H. S. and R. Freeman, Asst. Engineers; B. H. Annis, Francis Dawson, and corps of students of the Provincial Department of Technical Education; A. H. Drew, A. MacKay, Hiram Donkin, J. W. MacKenzie, H. B. Pickings, J. S. Hughes, T. G. Nicol, E. G. Partington and others.

†Consult, p. 20, above.

means of aneroid barometer, or by hand level. When possible, and in cases of existent structures, the heads were measured by tape line. Generally speaking, they must be regarded, only as approximations.

The column headed "Estimated low-water 24-hour horse-power for 8 months"† may be explained as follows:—Numerically considered, the majority of Nova Scotia's water-power sites would be practically inoperative for from three to four months of the year, namely, during the summer dry season. In many cases, however, artificial storage may be employed to tide over, to some extent, this low-water period. Considering the situation as a whole, the power possibilities of Nova Scotia's waters, from the standpoint of usability, may more fairly be presented in tables on an eight, than a twelve months' basis. The eight months column therefore gives the *estimated* least amounts of water-power that may be obtained continuously for 24 hours for eight months of the year. In some instances the estimated quantities of power given in the tables could not be obtained without utilizing some storage. On the other hand, at certain seasons much more power than is indicated may, in some instances, be developed. In addition to such general storage facilities, if means exist for locally storing the water for say 12 hours, then, practically double the listed amount of the horse-power might be obtained for the other 10 or 12 hours of the day. The fourth column gives *theoretical* quantities of horse-power. In practice only from about 65 per cent. to 80 per cent. of the theoretical horse-power may be obtainable.† Ice conditions which may limit operation during a portion of the assumed eight months period are not here taken into account, nor have allowances been made for the requirements of log driving.

If powers are to be dealt with individually and for special purposes, then data are demanded of a more precise and special nature than those here given.

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†For description of methods adopted in preparing tables, consult pp. 19–21 above.

NOVA SCOTIA

DISTRICT No. I.—MAINLAND EAST OF HALIFAX

	Site	Approximate Area of Watershed (in square miles)	Approximate Head (in feet)	Estimated low-water 24-hour H.P., 8 months. (Theoretical)	Remarks
	Kearney Lakes district:				
652.	Outlet of Birch Cove lake.....	6.2	10	7	
	Outlet of Kearney lake	11·7	80	100	Fall from Kearney lake to Paper-mill lake is 80 ft. in about ½ mile
	Outlet of Paper-mill lake	14.7	60	100	200 H.P. developed, Moir's paper mills
	Beaver-bank Lake district:				
653.	Long lake to Shubenacadie Grand lake	45·3	40	200	Fall of 40 ft. in about ¾ mile
	Beaver-bank lake to Long lake....	38·5	29	125	Fall of 29 ft. in about ½ mile
	Waverley Lake district: (Shubenacadie river)				
654.	Fletcher locks . . .	49	11	60	
	Foot of Miller lake	17.2	31	60	Partly developed. Descent Miller lake to lake Thomas is 93 ft. in about 1,500 ft.
	Rutherford's dam	14·3	28	45	Dam 12 ft. high
	Foot of Soldier lake	13·2	11	16	Old dam here. Descent of 155 ft. in 2 miles from Soldier lake to lake Thomas From Soldier lake to Miller lake 58 ft. descent in about ½ mile
	Acadia Powder Co	10·4	20	25	100 H.P. developed
	Portobello locks..	7·4	30	25	Fall of 30 ft. in about ¼ mile
	Dartmouth lakes:*				
655.	First Lake to sea .	12·4	67	95	Partly developed by Star Co. 200 H.P.; 67 ft. fall in about 2,000 ft.
	Lake Charles to Second lake ...	6·7	25	20	Lake Charles watershed included; fall 25 ft. in about 1,000 ft.

*See Water-power of Halifax County; N.S.: Dartmouth Lakes Power, by F.W.W. Doane, in Proceedings and Transactions of the Nova Scotian Institute of Science, Vol. xii. Part 1: pp. 21 to 23.

DISTRICT No. I—MAINLAND EAST OF HALIFAX—*Continued*

	Site	Approximate Area of Watershed (in square miles)	Approximate Head (in feet)	Estimated low-water, 24-hour H.P., 8 months. (Theoretical)	Remarks
Lake Major:					
656.	1st fall	28·9	20	65	Partly developed; fall of 20 ft. in about 400 ft.
	2nd fall	28·9	20	65	Partly developed; fall of 20 ft. in about 300 ft.
Echo lake:					
657.	1st fall	39·7	12	50	Fall of 12 ft. in about 600 ft.
	2nd fall	18·0	26	50	Old logging dam; fall of 26 ft. in about ½ mile.
Chezzetcook lakes:					
658.	Lower pond to sea	36	10	40	Fall of 10 ft. in about 1,000 ft.
	Chezzetcook lake to pond	36	25	100	Fall of 25 ft. in about ½ mile.
	Conrod lake to Chezzetcook lake	11	49	60	Dam at lake. Two small mills. Fall of 49 ft. in about 2,000 ft.
Musquodoboit river:					
659.	Logan mills	280	16	500	Old logging dam.
	Rollings mills	280	24	750	Dam for logging. Fall of 24 ft. in about 500 ft.
	Jam falls	280	29	950	Fall of 29 ft. in about 500 ft.
Mill lakes (Near headwaters of Musquodoboit):					
660.	Mill lake to Mill pond	17·7	80	160	Fall of 80 ft. in 1 mile; small dam here.
	Mill pond and Main river	17·7	160	300	Small dam; fall of 160 ft. in about 1½ miles.
Jeddore lakes:					
661.	Jeddore lake to sea	29.5	65	200	Fall of 65 ft. in about 1,800 ft.; logging dam at head; mill at foot.
Ship Harbour lakes:					
662.	Ship Harbour lake to sea	145	20	330	Fall of 20 ft. in about 1,000 ft.; old dam and saw mill.
663.	Fish river,				
	1st rapid	70·8	64	500	Fall of 64 ft. in about ½ mile.
	2nd rapid	70.8	82	660	Fall of 82 ft. in about ¾ mile.

DISTRICT No. I.—MAINLAND EAST OF HALIFAX—*Continued*

	Site	Approximate Area of Watershed (in square miles)	Approx. Head (in feet)	Estimated low-water, 24-hour H.P., 8 months. (Theoretical)	Remarks
Tangier river:					
664.	Tangier lake to sea	104	50–60	650	Fall of 50–60 ft. in about ¾ mile; head partly developed by Dominion Leasing Co.
	1st stillwater to Tangier	83	80	830	Fall of 80 ft. in about ½ mile.
	O'Brien lake to 1st stillwater	83	25	260	Old logging dam; fall of 25 ft. in about ½ mile.
Little West river:					
665.	West lake to sea.	18.5	48	100	Fall of 48 ft. in about ½ mile.
	Grand lake to West lake	18.5	62	130	Old logging dam; fall of 62 ft. in about ½ mile.
West river Sheet Harbour:					
665.	Sheet Harbour lake to sea	113	63	890	Fall of 63 ft. in about 1,000 ft.; about 25 ft. of head is now developed by saw mill.
	Union dam and Sheet Harbour lake (Little river)	14.3	170	280	Fall of 170 ft. in about 1½ miles.
East river Sheet Harbour:					
666.	1st fall	142	12	230	
	2nd fall	142	12	230	
	Gaspereau fall	142	25	480	
	Ruth fall	142	40	770	
	Malay fall	131	40	710	
	Marshall fall	131	35	620	
667.	Mulgrave river	35.1	15	60	Mulgrave river below Musgrave lake, has a fall of 100 ft. in about 4 miles.
	Seven-mile stream	20·0	7	16	Seven-mile stream below lake Como has a fall of 150 ft. in about 4 miles.
668.	Board Camp fall (15-Mile stream)	65·5	30	220	
	Cameron fall	93	20	210	
	Ragged fall	79	20	180	
	Governor Lake dam	13·3	20	30	Old logging dam.
	Ten-mile dam	23·8	15	40	Old logging dam.
	Fifteen mile river (below Sloan lake)	42·9	12	60	

DISTRICT No. I.—MAINLAND EAST OF HALIFAX—*Continued*

Site	Approximate Area of Watershed (in square miles)	Approximate Head (in feet)	Estimated low-water 24-hour H.P., 8 months. (Theoretical)	Remarks
Salmon river: (Halifax co.)				
669. Salmon river fall.	53·7	25	150	Fall of 12 ft.; banks 13 ft. high.
Moser river:				
670. 1st fall (old mill).	57·3	10	65	Old broken dam.
670. 2nd fall	57·3	10	65	
670. 3rd fall	57·3	12	80	
670. Round Lake dam.	41·4	15	70	Logging dam.
Ecumsecum river:				
671. Ecumsecum fall..	35·5	13	52	
671. Ball Alley dam site	23·3	23	61	Head obtainable by dam at gorge.
Liscomb river:				
Liscomb Mills fall	155	15	290	Situated at Highway bridge; old dam here.
Crooked fall	155	17	330	Steep rocky banks.
Big Still rapid (26 ft.) and Big fall	148	45	830	Developed for mining Company.
Little Liscomb River fall	62	40	280	Fall of 26 ft. which could be developed for 40 feet.
Mitchell Lake dam	57	15	100	Old dam.
McIntieth rapid. .	73	35	290	Fall of 35 ft. in about ½ mile.
672. Mulloy rapid	72	23	190	Fall of 23 ft. in about 2,000 ft.
Rainy Valley rapid (West br.)	72	23	190	Fall of 23 ft. in about 2,000 ft.
Camp lake fall and rapid (West br.).....	71	22	180	Fall of 22 ft. in about 700 ft.
Ladle Lake dam and rapid (West br.).....	69·3	18	140	Dam 8 ft. high; balance of fall occurs in 2,000 ft. of rapids.
Glencross rips (West br.)...	65	40	290	Narrow; high rocky banks; 40 ft. would back water up about three miles.
Keyhole to Jordan stillwater	16·0	72	130	High rocky irregular banks; 73 ft. would back water up about three miles.
673. Rush dam and Keyhole rapid..	15·4	20	35	Fall of 20 ft. in about 3,000 ft.
Big Liscomb dam	8·8	10	10	

DISTRICT No. I—MAINLAND EAST OF HALIFAX—*Continued*

Site	Approx. imate Area of Water-shed (in square miles)	Approx-imate Head (in feet)	Estim-ated low water, 24-hour H.P., 8 months. (Theor-etical)	Remarks
St. Mary river:				
674. Stillwater bridge to tidal water..	525	22	1,100	Head could be obtained by means of dam and flume.
Isaac Harbour river:				
675. Mining Co. dam..	30·3	98	340	Developed by about 4,000 ft. of flume; Dolliver Mining Co.
Larry river:				
Fall near tide-water.....	32·2	40	140	Fall of 40 ft. in about 600 ft.
Between Pine lake and forks	25·7	80	230	Could be developed by damming Duck run and diverting water from Bonnet lake., etc., into Round lake
East river; Pictou				
Eureka dam (west branch.....	51·7	12	40	About 50 ft. head might be developed on west branch by placing a dam about one mile up from Eureka dam and fluming down.
677. Forks at Ferrona junction (East branch.....	90·6	50	400	About 50 ft. might be de-developed on East branch by dam about ½ mile from Forks. The flowage from East branch might possibly be diverted near Forks into the West branch.
Salmon river (Colchester Co.)				
678. McMullen dam...	93	38	320	Fall of 58 ft. in about 3 miles; about 8 miles above Truro.
Stewiacke river; (Colchester Co.)				
679. Dickie's driving dam	374	7	240	About 4 miles above Stewiacke; dam 250 ft. long would give about 22 ft. head.

DISTRICT No. II.—MAINLAND WEST OF HALIFAX.

	Site	Approximate Area of Watershed (in square miles)	Approximate Head (in feet)	Estimated low-water 24-hour H.P., 8 months. (Theoretical)	Remarks
	Sackville river:				
	Foot of Webber lake	37·5	25	100	37 ft. available with Ellis' mill and flume. Partly developed.
	Ellis mill	37	12	50	25 H.P. developed.
	Outlet McCabe lake	36	8	30	
680.	Heffler and Webber mill	32	10·5	38	25 H.P. developed.
	Between 1st and 2nd stillwater	13	16·7	24	By dam near 1st stillwater
	Maxwell mill	2·5	10·5	3	20 H.P. developed; runs part of time only.
	Fenerty's old dam	12	10	13	Old dam.
	Pennant river: (Grand lake to Ocean)				
	First fall above tide water	30	30·6	100	Fall occurs in rapids 1,800 ft. long.
	Second fall above tide water	30	29·6	100	Fall occurs in about 600 ft.
	Pennant river: (West Branch)				
681.	Upper end of run, Ragged lake to Grand lake	16	22	50	One quarter mile between falls; rapids 500 ft. long.
	Lower end of run, Grand lake	16	5		
	Pennant river; (East branch)				
	Shehea lake to Grand lake	12	14·5	20	
681.	Shingle fall	6·5	10	7	High banks; fall in 450 ft.
	Otter fall	5·5	12	7	Fall in about 360 ft.; high rocky banks.
	Prospect river:				
	Above Nichols lake	9	8	8	Rapids; head of 14 ft. obtainable.
682.	Little Indian lake fall	8	10	9	
	Nine-mile river:				
683.	McGrath fall	36	11	45	Rapids 700 ft. long; might be dammed to 14 ft.
	Grand fall	25	6	17	Low banks.
684.	Horse Cross	24·5	6	17	Low banks.
	Fall	24·0	11	60	This fall and Gaspereaux about ¼ mile apart. High banks.
	Gaspereau	24·0	12		

DISTRICT No. II.—MAINLAND WEST OF HALIFAX—*Continued*

	Site	Approximate Area of Watershed (in square miles)	Approx. Head (in feet)	Estimated low-water, 24-hour H.P., 8 months. (Theoretical)	Remarks
	Margaret Bay road.....	22·5	11	25	Rapids 1,200 ft. long.
	Osier river:				
685.	Albert lake	24·5	6	16	
	Coucher lake	19·5	9	20	Dam here with 9 ft. head. High banks admit of 18 ft. head.
	East river:				
	Slaugenwhite mill	13·4	20	30	About 80 H.P. installed with 10 ft. dam, and 500 ft. steel flume.
686.	Fall at Railway ..	11·1	12	15	A long dam required.
	Little Lake fall ..	10·6	10	12	Proximity of Railway would probably prevent development.
	Northeast river:				
	Mason's mill.	35	10	40	60 H.P. developed. River drops 90 ft. in about ¾ mile to bay.
	Outlet, Mill lake	34·5	10	40	Log driving dam.
	Foot of Coon pond	32·3	139	500	Falls of 111 ft. in about 1-3 mile, or fall of 139 ft. in about ¾ mile.
686.	Above Coon pond	32·1	17	60	Pond could be raised 10 ft.
	Foot of Wright lake	31·2	39	130	
	Wright mill.....	22·2	8	20	Developed.
	Marsden's mill ...	22·1	21	50	Natural fall 19 ft.; partly developed
	Haverstock's mill	20	10	20	Small development here.
	Indian river:				
686.	Mouth of River..	70	105	840	Fall of 105 ft. in about ⅞ mile.
	Foot of Sandy lake	68	80	620	Fall of 80 ft. in about ½ mile.
	Ingram river:				
	New dam	58	16	100	
	Snake Lake dam .	57	11	70	
687.	Pogwa Lake dam.	54·5	13	80	High banks farther down stream.
	Davidson dam...	48·0	12	65	Logging dam; 30 ft. head obtainable.
688.	Hand Lake dam..	35·4	10	40	Old dam; banks admit of possible 20–25 ft. head.
	Foot of South lake	29·0	10	35	About 300 ft. above this, head of 35–40 ft. obtainable.

DISTRICT No. II.—MAINLAND WEST OF HALIFAX—*Continued*

	Site	Approximate Area of Watershed (in square miles)	Approximate Head (in feet)	Estimated low-water 24-hour H.P., 8 months. (Theoretical)	Remarks
689.	Mouth of river ..	29·8	13	45	Old mill not in use.
	Above Round lake	7·5	7	6	11 ft. head obtainable. Log driving dam.
	Cascade	6·8	20	15	Fall of 20 ft. in 200 ft.
	Old dam	6·5	6	5	12 ft. head obtainable.
	Outlet, Vinegar lake	14	21	30	Log driving dam.
	Vinegar lake to Otter pond	8·5	51	50	Fall of 31 ft. in about 300 ft. and 51 ft. in about 600 ft.
	Foot of Quack lake	8·3	14	13	Old driving dam; between Vinegar and Quack lake. Drop of 110 ft. in about 1¼ miles.
Dauphinee lake:					
689.	Outlet Sawlor lake	5·4	5	3	10 ft. head could be obtained
	Head of Sawlor lake	4·9	10	6	195 ft. fall between Dauphinee and Sawlor lakes.
	Outlet Dauphinee lake	4·1	5	2·4	11 ft. head could be obtained
Gold river:					
690.	The Mining Co. ..	120	9	140	About two miles above tide; partly developed.
	Mosher fall	118	35	540	35 ft. in about 1,000 ft.
	Myra fall.....	117	5	75	About one mile above Mosher.
691.	Salmon fall.	80·0	35	320	35 ft. fall in about 600 ft.; on main river near Holden Lake branch, said to be possible 70 ft. head in this vicinity.
	Holden lake outlet to Gold river ..	20	130–147	310	147 ft., or possibly 180 ft. head expected with dam at Holden lake and special development in connection with Gold river.
Martin river:					
692.	Daury mill.....	41	5·5	20	Some possible sites further up river.
Mushamush river:					
693.	Lunenburg Gas Co (electric plant).	55	22	140	Possible 24 ft. head. 400 H.P.
	E. A. Ernst	44	8	40	Saw and stave mill
	Lunenburg Gas Co	44	14	70	Might be deveolped with Ernst site.

DISTRICT No. II.—MAINLAND WEST OF HALIFAX.—*Continued*

	Site	Approximate Area of Watershed (in square miles)	Approx. Head (in feet)	Estimated low-water, 24-hour H.P., 8 months. (Theoretical)	Remarks
	Lahave river:				
	1st mill	616	12	925	Davison Lumber Co.
	2nd mill	616	14	1,080	Davison Lumber Co.
	3rd mill (Cook's)	616	19	1,470	
694.	4th Mill Hirtles, (West Northfield)	598	14	1,000	Saw and grist mill.
	Freda's	520	13·3	870	High banks; possible 40 ft. head.
	Wentzel lake	520	15	980	Saw mill.
	Morgan fall	304	32	1,220	Pulp mill at New Germany; 1,500 H.P. developed.
	Cheley	304	5	190	Grist mill.
695.	Zwicher	304	10	380	Old saw mill.
	Wheelock fall	136	10	155	Old saw mill site.
	Sink Spout	136	10·5	160	Fall of 10·5 ft. in about 400 ft.; high banks.
	North River: (Branch of Lahave river)†				
	Robar mill	87	13	130	Fall of 13 ft. in about 600 ft.; high banks.
	Apron Rock fall	87	22·5	220	Fall of 22½ ft. in about 500 ft.; good banks.
696.	Chute fall	87	37	370	Fall of 37 ft. in about 800 ft.; partly developed for saw mill.
	James fall	73	23	190	Fall of 23 ft. in about 500 ft.
	Veinot's	73	24	200	Fall of 24 ft. in about 300 ft.; high banks.
	North branch: (branch of Lahave river)				
	Black Rattle	191	10·5	230	Fall of 10·5 ft. in about 700 ft.; high banks.
697.	Mackie mill	191	6·0	130	Saw mill, box, sash and door factory.
	Indian fall	137	27·8	430	Fall takes place in about 600 ft.
	Jodrie fall	137	8·0	125	Saw and grist mill.

* First branch on the eastern side of Lahave river, above Wentzel lake.
† Above New Germany lake.

DISTRICT No. II—MAINLAND WEST OF HALIFAX—*Continued*

	Site	Approximate Area of Watershed (in square miles)	Approximate Head (in feet)	Estimated low-water 24-hour H.P., 8 months. (Theoretical)	Remarks
Petite rivière:					
	Petite rivière	76	5	45	Saw mill; near head of tide.
	Fault saw-mill	70	4	30	Saw mill.
	Harmon	52	5	30	Partly developed for saw mill.
	Crousetown	52	7	40	Partly developed.
	Naus	46	15	78	Saw mill.
	Crouse	39	35	155	Fall takes place in about three miles.
698.	Conquerall fall	37	9	38	
	Kaulbach	37	6	25	Might be combined with Conquerall fall.
	Bridgewater Electric Light Co.	26	25	74	Between Hebb and Fancy lakes; 325 H.P. developed.
	Between Milapskegechk and Hebb lakes	10	5	6	Between lakes.
	Between Milapskegechk and Minamkeak lakes	10	22	25	Between lakes.
Port Medway river:					
	Mill Village	602*	9·7	730	Saw mill; Davison Lumber Co.
699.	Salter fall	545	16·0	1,100	Nova Scotia Pulp and Paper Co.; 1,800 H.P. developed
	Big Salmon fall	532	4·9	330	Fall in about 300 ft.
	Poultice fall	508	9·0	570	Fall in about 750 ft.
	Glodes fall	486	8·3	500	Fall in about 500 ft.
	Big Rocky fall	486	12·0	730	Fall in about 800 ft.
700.	Bear fall	453	5·8	330	Fall in about 300 ft.
	Bangs fall	453	7·0	400	Shingle mill; possible to obtain 16 ft.
	Ponhook fall	437	17·6	960	Saw and shingle mill.
701.	Harmony pulp mill	125	30	470	Pulp mill; 1,000 H.P. developed.
Liverpool river:†					
	Milton lower fall	558	7–10	560	Several small mills and Milton electric plant.
	Milton upper fall	558	7–10	560	Saw mills.
702.	Cowie fall	558	20–22	1,550	Pulp mill; 1,500 H.P. developed.
	Rapid fall	540	33	2,250	Pulp mill; 3,000 H.P. developed.
	Guzzle fall	534	20–22	1,400	Town of Liverpool electric plant; 750 H.P. installed.

* This does not include the watershed of Salter, Aukle Jack, Long and Beavertail lakes, an area of twenty square miles.

† See *Water-Powers on the Mersey River, N.S.*, by W. G. Yorston in *Proceedings and Transactions of the Nova Scotian Institute of Science*, Vol. XI, Part 4, pp. 651-666.

DISTRICT No II—MAINLAND WEST OF HALIFAX—*Continued*

	Site	Approximate Area of Watershed (in square miles)	Approx. Head (in feet)	Estimated low-water, 24-hour H.P., 8 months. (Theoretical)	Remarks
703.	Lower Great Brook fall	496	7	435	Banks high on eastern side at foot of falls; fall in about 1,000 ft.
	Third Stillwater fall	496	5	310	Banks high on western side not very high close to river on eastern side; fall in about 800 ft.
	Cowpen fall	492	6	370	Banks low on west side some distance from river bank.
	Big fall	488	42	2,570	Banks fairly high on east side, falling off on west side; fall in about 5,000 ft.
	Hemlock river	475	10	600	Banks receding with drop of river on each side; fall in about 3,000 ft.
	Spring Bridge river	475	2·5	150	Banks flat; fall in about 500 ft.
	Lake fall (Indian Gardens)	453	73	4,200	Banks high near Gardens, but low and flat from Pollard river to foot of Lake fall; distance from Gardens to foot of Lake fall about 14,750 ft.
Broad river:					
704.	Leslie fall	94	27	230	
	Campbell fall	94	20	170	
Tom Tidney river:					
705.	Freeman dam	15	6	7	Developed; saw mill.
	Harlow dam	15	7	9	Developed; saw mill; dam might be raised to 10 or 12 ft.
	A. Harlow dam	15	7	9	Developed; carding mill.
	Harlow & Freeman Fall	15	8	10	Developed; saw mill.
		15	50	60	Fall of about 50 ft. in ½ mile.
Jordan river:					
706.	Miller & Son	184	10	230	Developed; mill; possible 15 or 20 ft.
	Old dam	184	12	275	
	Big fall	170	50	1,060	Fall of 50 ft. in about ¾ mile.
707.	Crane-neck fall	117	12	180	Fall of 12–15 ft. in about ¼ mile.
	Devils Back fall	117	12	180	Fall of 12–15 ft. in about ¾ mile.
	Hand fall	41·4	10	50	Fall of 10 ft. in about ¼ mile.

DISTRICT No. II—MAINLAND WEST OF HALIFAX—*Continued*

	Site	Approximate Area of Watershed (in square miles)	Approximate Head (in feet)	Estimated low-water 24-hour H.P., 8 months. (Theoretical)	Remarks
Roseway river:					
708.	Bowers dam	166	10	200	Developed; saw mill.
	Electric light dam	163	27	550	Shelburne municipal plant; 200 H P. installed.
	Hervey dam.	163	23	470	Dam, not completed.
	Bowers dam	163	8	160	Developed; saw mill; possible 15 ft. head.
	Miller Island fall.	163	12	245	
	T. Bower dam.	163	7	140	Former saw mill site.
	B. Bower dam	148	7	130	Developed; saw mill.
	J. I. Bower dam.	148	7	130	Developed; saw mill.
	Big fall	6·8	8	6	Fall of 8 ft. in about 1,000 ft.
709.	Jones & McGill dam	115	10	130	Developed; saw mill.
Clyde river:					
710.	Clyde River Pulp & Paper Co.	229	30	850	Developed; pulp mill.
Barrington river:					
711.	Doane dam	69	6	35	Developed; woollen mill.
	Long fall	69	6	35	Fall of 6 ft. in 300 ft.
	Island fall.	65	8	45	Fall of 8 ft. in 400 ft.
	Sorrow fall	65	10	60	Fall in over 200 ft.
	Weir fall	60	3	17	Fall of 3 ft. in 200 ft.
Tusket river; (West Branch)					
712.	Hulbert rapids	487	12	730	Rapids ¼ mile long, low banks.
	Reynard fall.	110	23	320	Rapids one mile long; low banks.
	Nine Partners	100	25–30	340	Developed by Yarmouth Electric Light & Power Co.
	Oak fall.	97	8	100	Dam 8 ft. supplying water for three mills at Carleton Centre.
	Bad fall.	84·8	30	320	Succession of rapids 1 mile long; good banks.
	Britain run.	85	3		Succession of rapids ¼ mile long; good banks.
	Dennis run	85	3		Succession of rapids ¼ mile long; good banks.
	Moody run	85	6	230	Succession of rapids ½ mile long; good banks.
	Harley run	85	3		Succession of rapids ⅛ mile long; good banks.
	Hicks dam	85	7		Log driving dam.
713.	French mill-dam	60	9	60	Developed at foot of lake Wentworth for lumbering purposes.

* These five small heads, it is said, might be used under special development with the head of 30 ft. at Bad fall.

DISTRICT No. II—MAINLAND WEST OF HALIFAX—*Continued*

	Site	Approximate Area of Watershed (in square miles)	Approx-Head (in feet)	Estimated low-water, 24-hour H.P., 8 months. (Theoretical)	Remarks
Tusket river: (East Branch)					
714.	Gavel Run.	369	8	370	Succession of rapids ½ mile long.
	Longs fall	369	6	280	Succession of rapids ½ mile long.
	Benneth falls	369	5	230	Succession of rapids ½ mile long.
715.	Bad fall.	172	18	380	Succession of rapids ½ mile long.
	Mill dam . . . . . (Prosser)	149	7	130	Developed by saw mill.
Salmon river; (Yarmouth Co.)					
716.	Wyman mill	59·5	8	40	Developed saw mill.
717.	Haley mill	41	6·6	25	Developed saw and shingle mill.
	Durkee mill	38	8·6	30	Developed saw, shingle and small flour mill.
	Cook mill	35	9	30	Developed saw mill.
	Crosby mill.	30·4	9	25	Developed; saw and shingle mill.
Salmon river; (Digby Co.)					
718.	Saulnier mill	52·5	8	35	Developed; wood working mill.
	Harrington mill . .	35·2	6	20	Shingle mill.
	Robicheau mill . .	19·3	24	40	Developed
Metagan river:					
	Deveau Mill	67	14	95	Developed; high banks
	Saulnier fall	52	8	40	From Saulnier's fall to Blackadar's mill river has high perpendicular banks; between these places there is a fall of over 50 ft.
	Fall	52	5	27	
719.	Fall	52	5	27	Fall of 30 ft.; high banks
	Split-rock fall	49	8	40	Fall of 20 ft.; high banks.
	Blackadar mill. . .	49	10	50	Developed; saw mill
	Raymond mill	46	12	55	" " "
	Alphonse Comeau's mill	46	12	55	" " "
	J. R. Comeau's mill	44	8	35	" " "

DISTRICT No. II—MAINLAND WEST OF HALIFAX—*Continued*

	Site	Approximate Area of Watershed (in square miles)	Approximate Head (in feet)	Estimated low-water 24-hour H.P., 8 months. (Theoretical)	Remarks
Weymouth river:					
	Pulp mill dam	293	60	2,000	G. P. Campbell pulp mill; 2,000 H.P. developed
720.	Sissibou fall	285	40	1,400	Pulp mill, not now in operation
	Schooner Passage fall	268	12	400	Dam site; 12 ft. fall in 800 ft.
	Moose fall and rips	236	15	440	Fall of 15 ft. in about ¼ mile.
	Wagner ledge	236	3	90	
721.	Devils Island fall.	222	27	750	Fall of 27 ft. in about ¼ mile.
	Burnt Camp rip	191	10	240	Fall of 10 ft. in about 400 ft.
	Gannet rip	191	15	360	Fall of 15 ft. in about 800 ft.
	The Gundy	191	20	480	Fall of 20 ft. in about 1,800.
Bear river:* (East Branch)					
	Rice's mill dam	68·6	12	75	Developed; W. H. Rice's mill.
	Old Welch mill site	68·6	102	630	Continuous rapids making 102 ft. fall in ¾ mile to Little Salmon hole; high banks.
	Big fall	64	120	700	High bank; Clark Bros.; 120 ft. fall of rapids in about 4,300 ft.
	Flat-rock rapid	64	.....	.....	½ mile long; high banks, estimated fall, rate 100 ft. per mile.
722.	Marshall fall	64	.....	.....	¼ mile long; high banks, estimated fall, rate 100 ft. per mile.
	Sheep rips	60	.....	.....	½ mile long; high banks, estimated fall, rate 100 ft. per mile.
	Stave Bridge rips.	53	.....	.....	¼ mile long; high banks, estimated fall, rate 100 ft. per mile.
	Old Thomas mill site	46	.....	.....	¼ mile long; low banks, estimated fall, rate 100 ft. per mile.
	Mulgrave Lake fall	37	.....	.....	¼ mile long; low banks, estimated fall, rate 100 ft. per mile.

DISTRICT No. II—MAINLAND WEST OF HALIFAX—*Continued*

	Site	Approximate Area of Watershed (in square miles)	Approx. Head (in feet)	Estimated low-water, 24-hour H.P., 8 months. (Theoretical)	Remarks
	Bear River* (West Branch)				
723.	Granite Works dam	43	12	50	Developed
	Bear River Elec. Lt. plant	43	65	25	Dam and pipe line development; installed 80 H.P.
	Parker fall	38	30	100	Fall of 10 ft. with total drop of 30 ft. in 300 ft.
	Old Mill fall	.....	.....	.....	½ mile rapids; high banks; estimated fall of 100 ft. per mile.
	Ansley Morgan mill site	35	.....	.....	¼ mile rapids; high banks; estimated fall of 100 ft. per mile.
	Sam Morgan mill site	35			Small head available; low banks.
	Long rips	32	.....	.....	¼ mile rapids; low banks; small head
	Big Stillwater dam	29	10	25	Driving dam.
	Cornell fall	24	.....	.....	¼ mile rapids; low banks; small head.
	Lake Jolly fall	21	.....	.....	¼ mile rapids; low banks; small head.
	Lake Jolly dam	21	10	.....	Log driving dam (steam mill).
	Lequille brook;				
724.	Dargie mill	49	8	45	Developed small mill.
	Town of Annapolis lighting plant	49	40	220	Dam 10 ft. and pipe line 630 ft.; development, 120 H P.
	Carr's carding mill dam	49	9	50	Developed
	Corbett mill dam	46	24	125	Developed
725.	Harnish mill dam	18	10	20	Developed; lumber mill
	Harnish upper dam	8	8	16	Storage dam being built
	Bloody creek:				
726.	Town of Bridgetown plant	.....	.....	.....	

* The character of the banks of Bear river admits of dams being placed at a number of sites, as indicated. No attempt has been made to insert estimates because of the optional character of the heads.

DISTRICT No. II—MAINLAND WEST OF HALIFAX—*Continued*

	Site	Approximate Area of Watershed (in square miles)	Approximate Head (in feet)	Estimated low-water 24-hour H.P. 8 months. (Theoretical)	Remarks
Paradise river:					
	Old mill site	40	20	70	Old 8 ft. dam; high banks; could be developed to 20 ft.
	Old dam	40	12	40	Log driving dam
	Fall	40	27	100	Falls and rapids; high banks 27 ft. drop in about 600 ft.; J. Longley
727.	Old dam	38	12	40	Log driving; high banks.
	Chutes fall	38	15	50	Fall of 15 feet in 100 feet; high banks.
	Sluice fall	38	120	400	Falls 22 feet, drop of 120 ft. in about 600 ft.
	Big fall	33	30	85	Drop of 30 ft. in 200 ft.; might be used with Sluice fall.
	Devils jaw	33	20	60	Drop of 20 ft. in 200 ft.; might be used with Sluice fall.
	Sanders dam	31	12	30	Log driving dam
Nictaux river:					
	Rodger mill	118	3·6	48	Wood working mill; power used to good advantage
728.	Old McKeown mill site	118	10	130	Possible small development.
	Nictaux fall	118	30	400	About 20 ft. drop in 100 ft. and, in all, 30 ft. drop in about 600 ft.
	Wambott fall	109	35	400	High rocky banks; 35 ft. drop in 1,200 ft.; possible development of 100 ft.
729.	Alpena falls	98	24	260	Rapids and falls giving 24 ft. in about 1,500 ft.
	Scotsman rip	90	20	200	Rapids about 20 ft. in 1,200 ft.
Gaspereau river:					
730.	Whiterock dam and Kneeland dam and run	126	12	190	Half-mile above White rock fall of 12 ft. between dams. Above Kneelands the river rises 41 ft. in 2½ miles.
	McCurdy fall	122	25·7	390	Series of rapids 1,200 ft. long; high banks.
	Jemines rips	108	18	240	Series of rapids 1,200 ft. long
731.	McAloney fall	108	56·5	350	Series of rapids 3,000 ft. long
	Redman run	108	10	130	Rapids 600 ft. long.
	Dories run	74	5	45	
	River near Lake	74	66·6	600	Series of falls and rapids ½ mile long, largest at Fish rock; 10 ft. high.

DISTRICT No. II—MAINLAND WEST OF HALIFAX—*Continued*

Site	Approximate Area of Watershed (in square miles)	Approximate Head (in feet)	Estimated low-water, 24-hour H.P., 8 months. (Theoretical)	Remarks
Avon river:				
732. Avon fall	70	40–45	360	
St. Croix river:				
733. Woollen mill dam.	92	7–8	80	Near highway bridge; developed.
733. Spence dam.	92	20–25	260	Fall in about 4,000 ft.
733. Paper Co. dam. . .	92	33	380	About ¾ mile above bridge; 1,000 H.P. developed.
733. Lumber Co. dam .	92	30	350	About ¼ mile above Paper Co.; developed.
733. Little dam	89	40–50	400	About ½ mile above Lumber Co.
734. The falls	83	8	82	About 1½ miles below Ponhook lake.
734. Ponhook dam . . .	78	8	77	At Ponhook lake.
Wallace river:				
735. Carr's mill dam . .	189	8	120	Developed; saw mill.
735. Howard dam	189	8	120	Developed; saw mill possible 12–15 ft.
36. Ogilvie dam	168	7	95	Developed; saw mill possible 10–12 ft.
Philip river:				
737. Ross mill	225	6	110	Grist mill; 40 H.P.; 225 sq.miles, area of watershed at Oxford.

NOVA SCOTIA

DISTRICT No. III.—CAPE BRETON*

Site	Approximate Area of Watershed (in square miles)	Approximate Head (in feet)	Estimated low-water, 24-hour H.P., 8 months. (Theoretical)	Remarks
Indian brook:				
738. Indian Brook	84	100	600	Fall 50ft.; banks 100 ft.
North river:				
St. Ann				
739. Little fall	61	60	290	High, vertical, rocky banks
Big fall	60	35	170	About ¼ mile above Little fall.

*There are some other small powers on some of the other rivers of Cape Breton, but it was not practicable to secure data respecting them in time for publication in this report.

NOVA SCOTIA

MEASUREMENTS OF FLOW OF RIVERS

Name of River and Location of Metering Station	Date	Hydrographer	Width of River where metered (in feet)	Area of River section (in sq. ft.)	Discharge (in cubic ft. per second)	Effective Drainage Area above Metering Station (in sq. miles)	Discharge in cub. ft. per sec. per sq. mile	Remarks
Lahave river above new highway bridge and opposite cottage on high hill	Sept. 17, 1910.	A. V. White.	84	176·8	195	600	·33	
Shubenacadie river at I.C. Ry. bridge at Enfield	Sept. 19, 1910.	H. A. Russell.	60	108	70	143	·50	Surface of river 9·3 feet from the top of top flange of lower chord of I.C.Ry. bridge
St. Mary river, one mile above still-water bridge	Sept. 17, 1910.	R. H. Cooper.	65	125·7	258	525	·49	After rainfall
Under still-water bridge.	Sept. 27, 1910.	R. H. Cooper.	120	413	586	525	1·11	
Clyde river, at bend near roadside about half-mile below pulp mill	Sept. 27, 1910.	A. V. White.	73	93·7	267	229	1·16	267 includes 30 c.f.s. for a quantity of water which did not pass directly through the metering station
Jordon river, about 300 feet above Deep landing, which is about one mile above tide water	Sept. 28, 1910.	A. V. White.	90	68·6	109	183	.60	

Sissibou river just below pulp mill dam at Weymouth.....	Oct. 5, 1910.	A. V. White.	28	28·6	24	190	·13	New dams being placed at outlets of certain lakes were holding back the main portion of flow. 195 sq. m. above the Gundy
East river, Pictou, (West branch) at Hopewell, foot bridge.....	Oct. 7, 1909.	R. H. Cooper . . .	50	57·5	99	52	1·90	
Medway river, at Mill Village bridge	Oct. 10, 1910. . . .	A. V. White.	110	175·8	109	602	·16	River surface 14 feet from bottom of iron floor, I beam nearest north end of bridge
Liverpool river, in canal below head gates leading to municipal pond.....	Oct. 11, 1910. . . .	A. V. White.	44	99·5	127	534	·24	Only one gate said to have been open at the Gardens. Two gates usually open at this season of year
Gaspereau river, about 200 yds. below junction of Black creek, near White Rock	Oct. 22, 1910. . . .	A. V. White.	54	50·9	75	77	1·03	Dam at outlet of Gaspereau lake said to have been closed at time of metering. The 77 sq. miles excludes Gaspereau lake and includes Black river

CHAPTER VI

The Inland Waters of Prince Edward Island

THE province of Prince Edward Island has no considerable areas of elevated land and has, practically, no inland lakes. The areas of the individual watersheds of its rivers are small, and, in addition, the majority of the rivers are tidal for several miles up from their mouths. The inland waters of the Province are, therefore, not capable of producing much water-power.

The Crown lands have all been granted. There are no laws upon the statute books relating to the control, regulation, or pollution of rivers. Neither is there any legislation relating to the valuable underground waters of the Island* either as regards their conservation or the rights to them.

During certain seasons of the year, small water-powers having heads of from 8 to 12 or 15 feet, and developing from 5 or 10 up to 50 horse-power, are in use upon the majority of the rivers. These developments are generally used in small grist, wool-carding and other mills. In a few instances, individual developments may be had of from 50 to 100, or more, horse-power.

The lands of the Province are held in relatively small holdings. Consequently, even where higher heads, or larger areas for storage reservoirs for power development, might be obtained, the compensation to owners of overflowed property would be prohibitive to such undertakings.

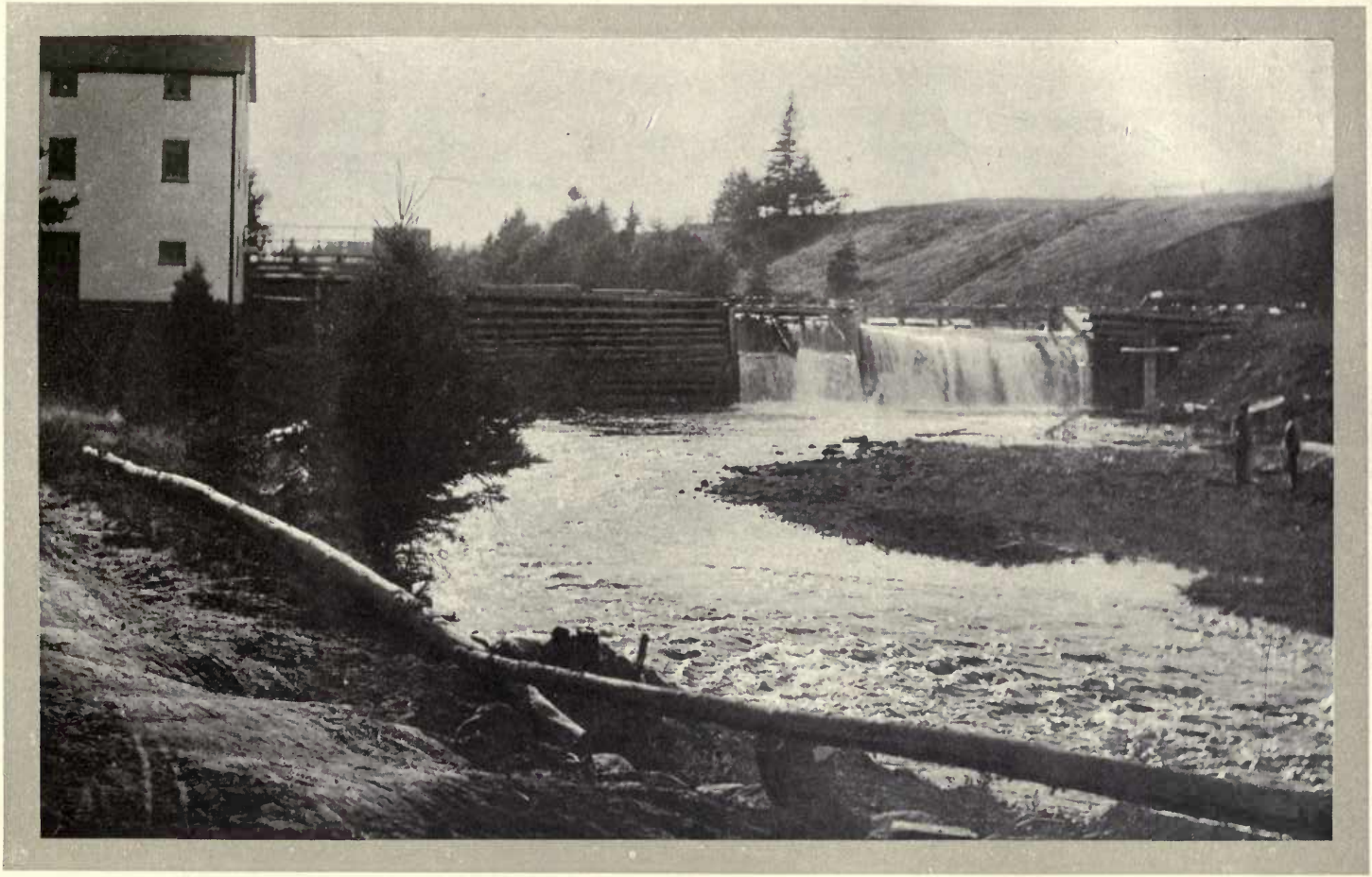
In Kings county the principal rivers are the Murray, the Montague—upon which is located a hydro-electric plant supplying the village of Montague—and the Morrell, which is said to admit of some further water-power development. Some good small powers are in use upon such waters as Big Pond, the Midgell, the Sturgeon and Seal rivers.

In Queens county the prominent Hillsborough river is tidal up to the aboideau at Mount Stewart. Considered from the standpoint of power development, the large rivers are the Winter, the West and the Tryon, upon the latter of which is a small hydro-electric development at Tryon. Upon some smaller rivers such as the Westmorland, Sable, Wheatley and Old Mill, small mills, driven by water-power, are in operation.

In Prince county the principal river, from a power standpoint, is the North Dunk upon which are some small mills. Other small mills are situated upon such rivers as the Ellis, Trout and the Tignish.

Some maps of Prince Edward Island indicate a large number of saw and grist mills, but many of the small mills formerly in service have been

*Regarding underground waters see pages 3-6, above.



HYDRO-ELECTRIC DEVELOPMENT, MONTAGUE RIVER, PRINCE EDWARD ISLAND

abandoned. Reporting upon the inland waters of the Island, James B. Hegan, District Engineer of the Department of Public Works, Canada, says:

> "In years past before the clearing away of the forests and when lumber was abundant, there was much more water; many streams then of good size and having on them several mills have now become almost dry, and quite useless for power, and as such change is going on further with the clearing up and cultivation of the land, Prince Edward Island may be considered as being, practically, about without water-power."

The chief value of the inland waters of the Province consists, not in their water-power possibilities, but in their use for domestic and municipal water supply, for agricultural purposes, and as waters for the propagation of trout and other salt-water fish.

The value of the fishing as an attraction to tourists is very considerable and should not be underestimated. There are dams upon some rivers which have no fish-ways in them, such, for example, as the Sturgeon, West, Seal and other rivers. Failure to facilitate the entrance of fish to the upper reaches of the rivers for spawning purposes and failure, also, to protect them, not only makes the fish scarce in the rivers themselves, but also causes depletion of the supplies of smaller fish in the vicinity of such rivers. This, in turn, renders the coast less attractive as a feeding ground for the fish caught for the various food markets.

CHAPTER VII

The Water-Powers of New Brunswick

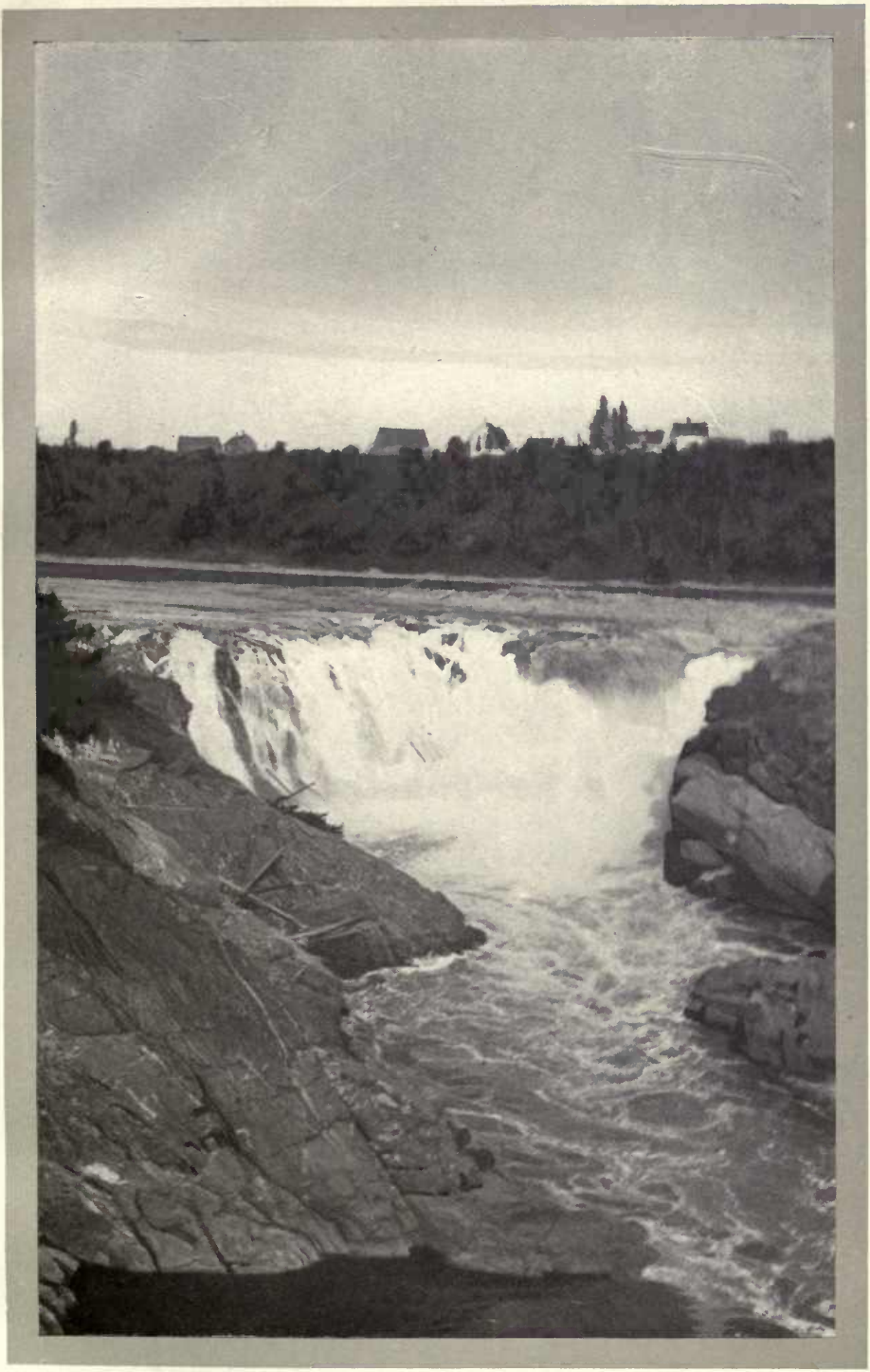
THE province of New Brunswick has a remarkable and valuable river system. The larger rivers, for the most part, are long, and their fall gradual. Many which flow into the sea have fine harbours at their mouths, while the larger ones are themselves navigable for large vessels for many miles. The St. John river, while navigable in its lower reaches for large vessels, is practically navigable for small craft to Grand falls, a distance of about 225 miles from the sea. The Miramichi, the Restigouche and the Petitcodiac, are also navigable for, say, fifteen to twenty-five and more miles from their respective mouths. Tributaries of some of these rivers, such for example, as the Tobique, Madawaska, and the branches of the Miramichi, are navigable for small craft.

Characteristics Affecting Development

If the rivers of New Brunswick are viewed from the standpoint of water-power development, two facts stand out prominently, first, that important interests connected with navigation and lumber driving have already been established, and are dependent for their successful operation, upon the maintenance of the navigable properties of the water highways of the Province. Any development for power purposes upon the main rivers would, therefore, have to be very seriously weighed before being undertaken, in order not to interfere with the rights and privileges of existing interests. Secondly, there are comparatively few lakes in the upper portions of the watersheds of the majority of the rivers and, hence, little facility is afforded for the natural storage of waters for the purpose of equalizing the flow during the low-water periods.

The south-westerly portion of the Province, lying between the St. John and the St. Croix rivers, is studded with a number of lakes where waters may be stored. The principal rivers in this district, the Magaguadavic (see illustration), Lepreau, Musquash (see illustration) and especially the St. Croix, have marked falls throughout their lower sections, several of which have already been developed. Power developments exist upon the Aroostook (see illustration) and the Meduxnekeag, while others of various magnitudes exist elsewhere throughout the Province. The point to emphasize here, however, is that a cursory inspection of the map of the Province reveals the fact that New Brunswick is not studded with lakes, as is the case in Maine and in Nova Scotia.* A careful and

* New Brunswick has an estimated land area of 27,804 square miles and an inland water area of 181 square miles. Compared with this Nova Scotia has land, 21,608 square miles, and water, 820 square miles (See White's *Atlas of Canada, 1906*), and Maine has land, 29,895 square miles, and water, 3,145 square miles.



GRAND FALLS, ST. JOHN RIVER, NEW BRUNSWICK

adequate investigation in the field is required before anything like a proper statement can be presented respecting the water-powers of the Province; and such an investigation is the more necessary on account of the comparative scarcity of inland lakes, or known storage reservoir sites. Certainly, if basins where artificial storage may economically be created, be not found, then the watershed areas will have to be discounted when viewed as a chief factor governing continuous water-power development.

The tributaries of the large rivers, and also, the majority of the smaller rivers directly entering the sea, may be said to be mountain streams, which, in most instances, have a rapid fall, and a rapid run-off. The general character of such streams may be appreciated from the accompanying illustration which is a view looking over the brink of Tetagouche falls down the valley of Tetagouche river. Here are seen the steep, wooded, side hills so markedly characteristic of the majority of New Brunswick's smaller rivers.

Laws Relating to Inland Waters of New Brunswick

In addition to the claims which domestic and municipal water supply have upon the inland waters of New Brunswick, various rights and privileges to make use of the inland waters, have been granted by the Provincial Legislature, to fishery, boom, log-driving and other interests. Such interests have, now, vested rights, which must be protected against any encroachments that might result from the development of water-powers upon waterways already in use for other purposes. The following indicates, very briefly, the general character of some of the rights and privileges which have precedence over proposed water-power developments.

With regard to the rights of navigation,* it need here only be stated that, while the New Brunswick Legislature has conferred various powers upon boom, log-driving and other companies, yet, such powers have only been granted conditionally upon the maintenance of free navigation for "vessels, boats or other craft."

The Fisheries Act† provides for the granting of leases, licenses or permits, for fishing in the inland waters. These are granted for various terms up to ten years, and are disposed of by public auction. The revenue to the Province from such sales amounts to about $15,000 per annum. In some instances the development of water-power sites would spoil natural salmon pools, and thus lessen the rental values of some of the fishing privileges.**

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*Respecting some of the general factors involved in the protection of navigation interests, see, above pp. 1 *et seq*; especially pp. 6–9.

†See *Consolidated Statutes*, 1903, chap. 34; also, "An Act to Amend the Fisheries Act", 7 Ed. VII, chap. 31. Consult also, "An Act to regulate the Leasing of the Fishery Rights in the non-tidal waters pertaining to the Crown as Riparian Proprietor of ungranted Crown Lands, and for the Protection of the Fisheries," being 47 Vict., chap. 1. (N.B.)

**Respecting fishways in dams, see p. 198

Log Driving And Boom Companies

Various companies have been incorporated to engage in the business of log driving. The general character of the powers conferred upon these companies may be understood from the following clause taken from the Act* relating to one of such companies. The rivers having been named, and the portions of the rivers involved having been specified, the Act empowers the company

> "to place, use and maintain all such necessary and reasonable booms and piers as will facilitate the said driving, and to do anything upon said rivers, or either of them, between the points aforesaid, that any person or persons, might or could hitherto legally have done, for the purpose of driving logs down said rivers or either of them, between the points and places aforesaid, and they may remove from the beds of said rivers stones, rocks, and such like obstructions to the free running of the water and the driving of the logs down to the said rivers between the points aforesaid, and may generally improve the said rivers as highways for the driving and running logs down the same, and it shall be the duty of the said company, and any person or persons acting under authority of this Act, in driving logs as is herein provided, to do such driving with all reasonable speed, and to make a clean drive of the same between the points and places mentioned in this Act."

Again, various companies have been incorporated by the government for the purpose of constructing, maintaining and operating, upon many of the large rivers of the Province, booms for use in connection with the driving of logs and lumber.†

Under the Act intituled "Respecting Dams and Sluiceways"** subject to the recommendation of the surveyor of dams, and to the approval of the county council, a sluiceway to drive lumber over any dam erected, or to be erected across a stream, or river, must, upon the request of any person requiring such sluiceway, be provided by the owner or occupier of the dam.

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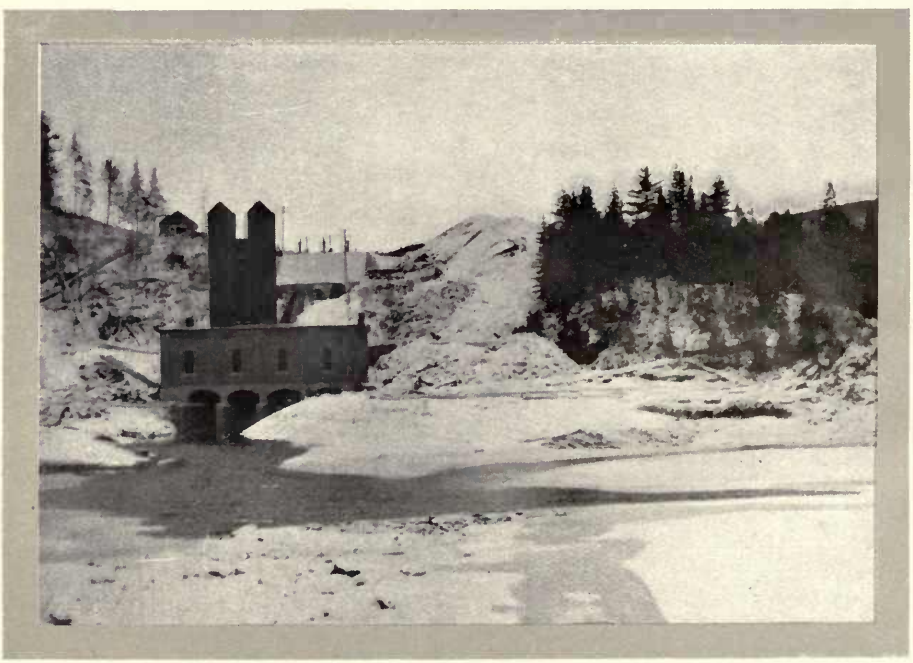
*See Section 4 of "An Act to consolidate and amend the various Acts relating to the St. John River Log Driving Company", being 9 Ed. VII, chap. 76. (N.B.). See also, 49 Vict., chap. 51; 50 Vict., chap. 64; 53 Vict., chap. 64; 57 Vict., chap. 79; 4 Ed. VII, chap. 82; and 7 Ed. VII, chap. 59, relating to the acquirement of the property and assets of the Fredericton Boom Co.

†The general character of the rights and privileges enjoyed by boom companies may be understood from "An Act to continue the Fredericton Boom Company, and to consolidate and amend the several Acts relating to the said Company," being 51 Vict., chap. 53. See, also, New Brunswick Acts, 7 Vict., chap. 34; 8 Vict., chap. 90; 11 Vict., chap. 50; 18 Vict., chap. 14; 32 Vict., chap. 28, also 31; 38 Vict. chap. 38.

**Consolidated Statutes, N.B., 1903, chap. 174, pp. 2219–20.

Photo by A. V. White.]

MAGAGUADAVIC RIVER, NEW BRUNSWICK. WATER-DRIVEN PULP MILL, CONTAINING ALSO AN ELECTRIC GENERATING STATION



POWER HOUSE NEAR MOUTH OF AROOSTOOK RIVER, NEW BRUNSWICK

Photo by A. V. White.]

LOOKING DOWN THE TOBIQUE RIVER, NEW BRUNSWICK

Photo by A. V. White.]

FIRST FALLS, HEAD OF TIDE, MUSQUASH RIVER, NEW BRUNSWICK

Riparian Ownership

There are between seven and eight millions of acres of land yet in the possession of the Crown. The status of the Province as a riparian owner is defined by a special provincial Act* passed on April, 1, 1884, which states that,

> "In all Grants hereafter to be made of Crown Lands adjacent to the following rivers and streams:—Nepisiguit River, Jacquet River, Upsalquitch River, Quatawamkedgwick River, Restigouche River, Charloe River, Patapedia River, Middle River, Little River, Tattagouche River, Big Tracadie River, Tabucintac River, Dungarvon River, Renous River, North West Miramichi River and Branches, Kouchibouguac River, Kouchibouguacis River, Richibucto River, Green River and Branches, Tobique River and Branches, and all such other rivers, lakes and streams as the Governor in Council may hereafter declare by Proclamation published in the Royal Gazette,—there shall be reserved to the Crown a strip or portion of land, four rods in width from the banks of the streams or lakes on each side thereof, and the riparian ownership of the said streams shall remain wholly vested in the Crown; provided always, that the owner or occupier of any lot abutting upon said strip of land shall have a right of way across the same to and from the said river or stream."

Statutes Relating to Water-Powers

Special legislation respecting water-powers was enacted by the Province consequent upon an application to develop the Grand falls—the most important water-power in the Maritime Provinces, and one of the larger water-powers of Canada.

On April 16, 1903, an Act intituled "An Act to authorize the leasing and development of water-power at Grand falls"† was passed, empowering the Lieutenant-Governor in Council by letters patent, to incorporate, upon expressed conditions, a company for the purpose of developing the power. Provision was made for the acquirement of lands, rights and privileges at Grand falls, and for the payment of rental for leases, etc., to the Government.

Later, it was deemed desirable to extend the authority conferred by this Act upon the Lieutenant-Governor in Council, to include all the water-powers that then were, or that might come, under the control of the Province. Consequently, on April 20, 1904, the Legislature passed an Act** giving the required extension of authority, and stating that,

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*See "An Act to provide for the Survey, Reservation and Protection of Timber Lands." 47 Vict., chap. 7. (New Brunswick.) By 53 Vict., chap. 17, exception respecting the reservation is made in the case of persons who had made *bona fide* application for lands prior to the passing of the Act, 47 Vict., chap., 7. See, also, *Consolidated Statutes*, 1903, chap. 27, sect. 4, pp. 331–2. This reserved strip is also referred to in the Fisheries Act. *Con. Stat.*, 1903, chap. 34, p. 459.

†Act, 3 Edward VII, chap. 3, (New Brunswick).

**4 Ed. VII, chap. 32, (New Brunswick).

"Whenever the Lieutenant-Governor in Council may think it desirable in the public interest so to do, he may acquire by agreement, or by expropriation, as hereinafter provided for, in the name of His Majesty, any water-powers, rights or privileges within the Province, and the necessary land to enable such water-powers to be properly developed; provided, that he shall not expend or incur a liability for upwards of ten thousand dollars for such purpose without the approval of the Legislative Assembly first being obtained by resolution, which approval shall not be granted unless any water-powers already acquired under this section have been re-sold or leased on terms satisfactory to the Legislative Assembly."

The Act provides for expropriation powers, defines the manner in which they shall be exercised, and provides for the payment of damages by the Government when such are incurred.

The Act further states that,

"The Lieutenant-Governor in Council is hereby authorized to lease, or sell, either by public auction or private contract, any such lands, rights and privileges to any corporation desiring to utilize any such water-power and convincing the Lieutenant-Governor in Council of its ability to develop and utilize the same for industrial purposes, upon such terms and conditions as to the development and utilization of the same as the Lieutenant-Governor in Council may prescribe, and it shall be lawful for the Lieutenant-Governor in Council by letters patent to incorporate a company to acquire any such water-power, property, rights and privileges; and the Lieutenant-Governor in Council may embody in such letters patent all necessary provisions for the acquiring and expropriation of such lands, interest in lands, rights and privileges, as he may deem necessary, and all the powers, rights and privileges which shall be conferred on such company by such letters patent, shall be as valid and effectual as if the same had been conferred by Act of the Legislature of New Brunswick."

The Legislature, therefore, has it within its power to do much to harmonize the various interests concerned in the use of the inland waters. By thus harmonizing interests, waters may be apportioned to the best general advantage, and, wherever it is deemed advisable, they may be made available for power development.

Reconnaissance Survey

In the autumn of 1910, a hasty reconnaissance was made of some of the inland waters of New Brunswick in order to judge of their water-power possibilities. Data were gathered by the New Brunswick offices of E. T. P. Shewen, J. K. Scammel, and Geoffrey Stead of the Department of Public Works, Canada. Other data, especially that relating to the discharges of the rivers, below given, were kindly furnished by the International Commission Pertaining to the St. John River. Again, data were also obtained by special enquiry and

by correspondence. Such data have been tabulated in order to represent the estimated possible horse-power at various power sites. It must be regarded as a rough estimate only, based on information avowedly insufficient, but, nevertheless, the best procurable under the circumstances.*

International Commission, River St. John

Prior to 1904, certain piers and other works had been constructed in the St. John river for use in connection with the operations carried on by certain lumbermen and mill-owners. These works were said to be a menace to other commercial interests dependent upon the use of the river. Some conception of the magnitude of the interests involved may be formed from a knowledge of the fact, that, for the last few years, there has been an average annual drive of 120,000,000 feet of lumber (logs) on the St. John river above Grand falls. About seventy-five per cent. of this quantity passes over the falls to points farther down the river. During 1904, application by the St. John Lumber Co.—a United States company—requesting the power to construct more piers and other obstructions in the river, was pending before the legislature of the state of Maine. This application prompted the Executive Council of New Brunswick, in 1904, to bring the matter to the attention of His Excellency the Governor General of Canada; and in 1905, lumber interests at St. John, N. B., also petitioned His Excellency to take steps to bring the condition of affairs existent upon the St. John to the attention of the United States Federal Government.†

It was claimed by the petitioners that the works which had been constructed constituted a violation of what is commonly known as the Ashburton Treaty, of 1842, Article III of which states that:**

> "In order to promote the interests and encourage the industry of all the inhabitants of the countries watered by the river St. John and its tributaries, whether living within the state of Maine or in the province of New Brunswick, it is agreed that, where, by the provisions of the present treaty, the river St. John is declared to be the line of boundary, the navigation of the said river shall be free and open to both parties, and shall in no way be obstructed by either; that all the produce of the forest, in logs, lumber, timber, boards, staves or shingles, or of agriculture, not being manufactured, grown on any of those parts of the state of Maine watered by the river St. John, or by its tributaries of which fact reasonable evidence shall, if required, be pro-

*Consult Chapter II, above, on *Water Power Data;* also, p, 19, on *Reconnaissance Surveys.*

† For early references to the difficulties existing upon the St. John river, see, *Report of the International Waterways Commission,* 1906, being *Sessional Papers,* (Canada), No. 19 a, 1907, pp. 4 *et seq;* also, for diplomatic correspondence between Canadian and United States governments, see *Ibid,* pp. 19 and 20 *et seq.*

** See Hertslet's Commercial Treaties, (London, 1845), Vol. VI., pp. 856-7; or, *Treaties and Conventions concluded between the United States of America and other Powers since July* 4, 1776. (Gov't. Pub.), Washington, 1889, pp. 434-5.

duced, shall have free access into and through the said river and its said tributaries, having their source within the state of Maine, to and from the seaport at the mouth of the said river St. John and to and around the falls of the said river, either by boats, rafts or other conveyance; that when within the province of New Brunswick, the said produce shall be dealt with as if it were the product of the said province; that, in like manner, the inhabitants of the territory of the upper St. John, determined by this treaty to belong to Her Britannic Majesty, shall have free access to and through the river, for their produce, in those parts where the said river runs wholly through the state of Maine: Provided, always, that this agreement, shall give no right to either party to interfere with any regulations not inconsistent with the terms of this treaty which the governments, respectively, of Maine or of New Brunswick may make respecting the navigation of the said river, where both banks thereof shall belong to the same party."

Appointment of Joint Commission

It had been thought that the subjects in dispute would be taken up by the then recently appointed International Waterways Commission, but it was afterwards decided that the St. John river was outside the scope of its investigation. Consequently, a new commission, now known as the International Commission Pertaining to the St. John River, was appointed "to investigate and report upon the conditions and uses of the St. John river, and to make recommendations for the regulation of the use thereof by the citizens and subjects of the United States and Great Britain, according to the provisions of treaties between the two countries."*

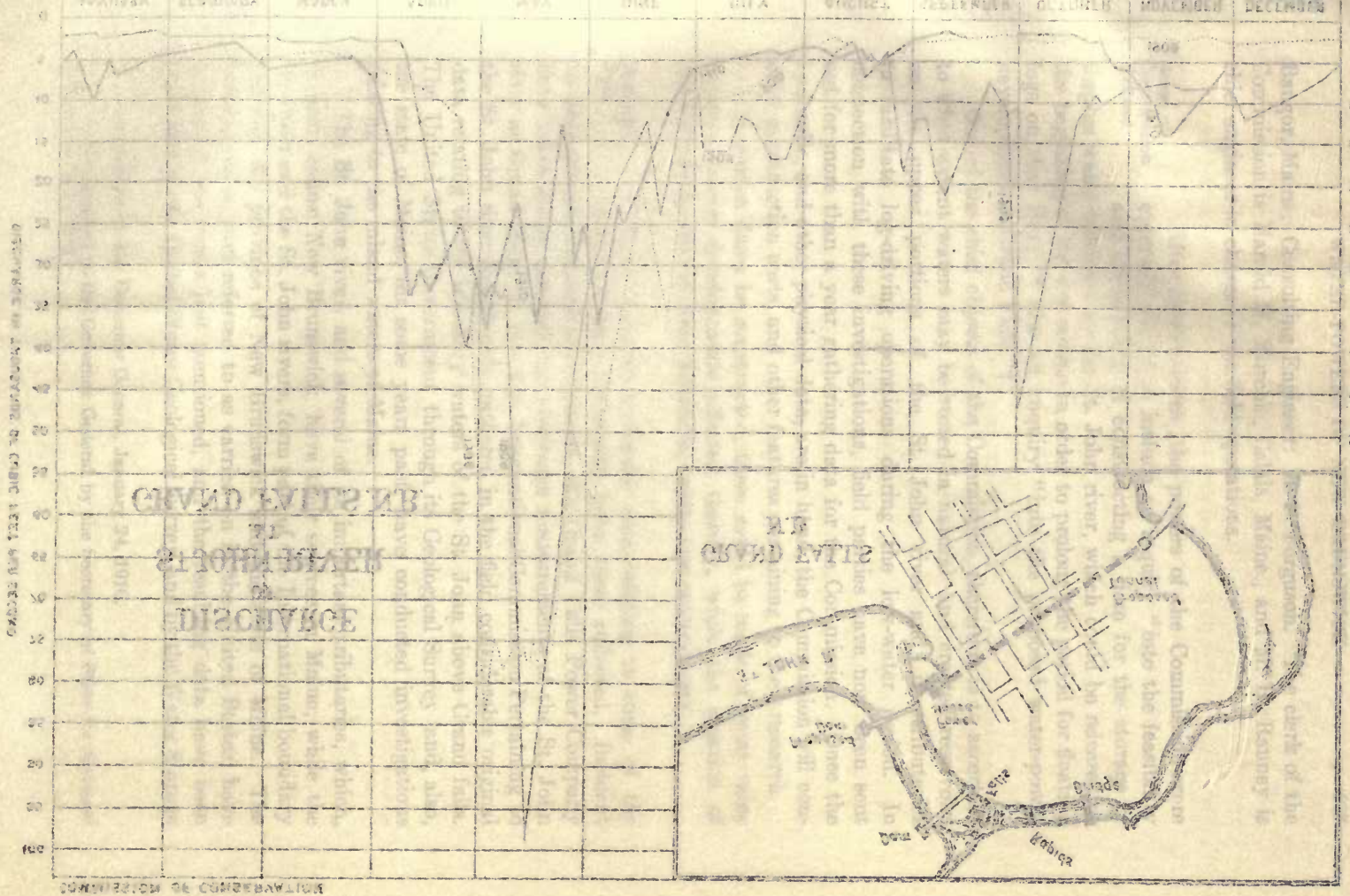
The personnel of the commission is constituted as follows: On behalf of Canada†, Commissioners: A. P. Barnhill, St. John, N. B., John Keefe, St. John, N. B.; Counsel: A. J. Gregory, Fredericton, N. B.; W. P. Jones, Woodstock, N. B.; Consulting Engineer: S. J. Chapleau. On behalf of the United States**, Commissioners: George A. Murchie, Calais, Maine, P. C. Keegan, Van Buren, Maine; Counsel: Oscar F. Fellows,

* See *Report of the Privy Council, Canada,* August 13, 1906, for circumstance associated with the formation of the Commission. For legislation by U.S., see, *Statutes at Large,* 59th Cong., 1st sess., Vol. XXXIV., chap. 337, p. 292: also *Ibid.* 60th Cong. 1st sess. Vol. XXXV, chap. 183, pp. 177-178; also *Ibid.* 61st Cong., 2nd sess., chap. 62, p. 203: also *Ibid.* 61st Cong. 3rd sess., Chap. 240, p. 1290.

† The appointment of the Canadian Commissioners was approved by the Governor General on December 3, 1908.

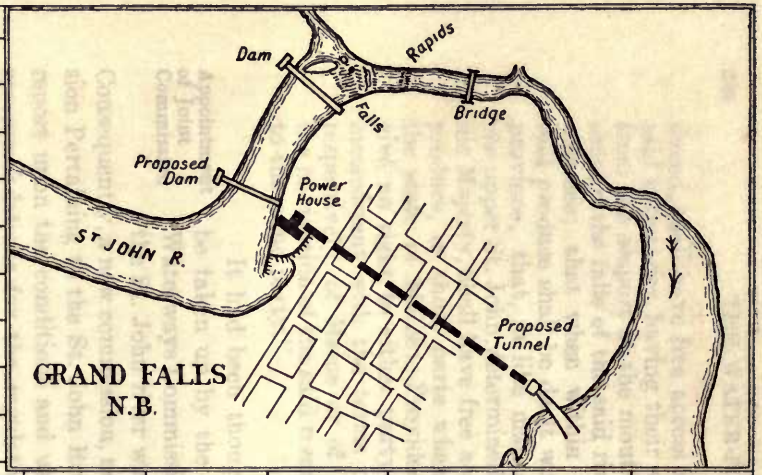
**The appointment of the United States Commissioners was made by the President, on January 12, 1909. The document appointing the Commissioners defines their functions, in part, as follows: "I do appoint him a commissioner on the part of the United States in a Joint Commission to investigate and report upon the conditions and uses of the St. John river, and to make recommendations for the regulation of the use thereof by the citizens and subjects of the United States and Great Britain, according to the provisions of treaties between the two countries." On February 18, 1910, the Department of State considered the instructions already issued as sufficient to authorize the Commissioners "in their discretion to examine and report upon the proposed water-power development at Grand falls on the St. John river, in relation to the provisions of Article III of the Treaty of 1842 between the United States and Great Britain."

For subsequent legislation, see *Statutes at Large,* 61st Congress, 2nd Sess., chap. 62, page 203, also 61st Congress, 3rd Sess., chap. 240, p. 1290.



COMMISSION OF CONSERVATION

DISCHARGE OF St. JOHN RIVER AT GRAND FALLS N.B.



DISCHARGE IN THOUSANDS OF CUBIC FEET PER SECOND

100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0

1908 1909 1910 1909 1908 1910 1909 1910 1908

JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER

Bangor, Maine; Consulting Engineer: H. S. Ferguson. The clerk of the Commission is Harold H. Murchie, Calais, Maine., and M. H. Ranney is chief engineer in charge of the field operations.

Scope of Commission Defined

After appointment, the powers of the Commission were expressly stated to include an inquiry "into the feasibility and advisability of constructing a dam for the storage of surplus water tributary to the St. John river, which could be released at the beginning of the dry season in order to prolong the period for floating logs on that river;"* also an enquiry "into the proposed water-power development at Grand Falls."†

One of the chief objects of the Commission, therefore, is to ascertain to what extent waters may be stored in natural and created reservoirs on the upper portions of the St. John river and its tributaries to facilitate log-driving operations during the low-water period. In connection with these investigations, field parties have now been sent out for more than a year gathering data for the Commission. Once the hydraulic, and other physical data, are in hand, the Commission will consider construction costs, and other features pertaining to their research.

If storage dams be constructed, these could be made of great value to water-power developments affected thereby, while the creation of reservoir dams will, in some instances, create new water-power.

Hydraulic Data

Some valuable hydraulic data relating to some of the rivers of New Brunswick have been collected. Incident to their proposed power development, the Grand Falls Power Company have taken gauge readings and discharge measurements of the St. John river at Grand Falls, N. B. The International Commission Pertaining to the St. John river has already gathered in the field considerable original data relating to the tributary waters of the St. John above Grand falls. The United States Government through its Geological Survey and, also, the state of Maine, for some years past, have conducted investigations relating to the inland waters of Maine.

The St. John river, and several of its important tributaries, which, in part, course New Brunswick, have their sources in Maine, while the St. Croix and the St. John rivers, form part of the International boundary between the province of New Brunswick and the state of Maine. The investigations, just referred to as carried on in the United States, have comprised the rivers just mentioned, and the resulting data have been published by the United States Geological Survey, and by the Water Storage

* Approved by the Governor General, January 24, 1910.

† Recommended to the Governor General, by the Secretary of State for External Affairs, March 8, 1910.

Commission of the state of Maine. These data are of value in connection with the study of the water-power possibilities of many of the rivers of New Brunswick, as well as of those elsewhere in Canada, and, consequently, have been drawn upon for some of the statements which follow.

Rainfall Records

In New Brunswick, the annual precipitation ranges from about 35 to 47 inches.* The records of rainfall in various parts of the Province are comparatively meagre, and, quite insufficient to enable estimates of rainfall supply of respective watersheds to be made. This absence of records makes the data already available as the result of steam gauging and metering, much less serviceable than it would otherwise be.

It would be an advantage to have an additional number of rainfall gauging stations established under the direction of the Meterological Service. The equipment for such stations is inexpensive, being about three dollars for a rainfall station only, and about twenty-five dollars additional for a thermometer equipment, including cabinet. The Meteorological Service will be glad to furnish apparatus to establish rainfall stations, free of charge, to any person, suitably situated, who will voluntarily attend to making and transmitting the observations.

Evaporation

The United States Geological Survey has had measurements made to determine the evaporation in the state of Maine. Evaporation stations were established and maintained as follows:†

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* Consult, *Rain- and Snow-Fall of Canada to the end of* 1902, Ottawa, 1906. (Meteorological Service, Department of Marine and Fisheries). Mean annual precipitation records for the following New Brunswick stations: Bass river, Bathurst, Chatham, Dorchester, Dalhousie, Fredericton, Grand Manan, Moncton, Point Escuminac, Point Lepreaux, Parker's Ridge, St. Andrews, St. Stephens, St. John, Sussex, Woodstock, will be found. *Ibid*, pp. 48-49. Since 1902, some of these stations have been discontinued and others established.

Respecting monthly records of rainfall and snowfall for Chatham, see pp. 102-103, also pp. 166-167; for St. John, see pp. 108-109, also pp. 118-119, also pp. 172-173; for Grand Manan see pp. 110-111, also pp. 174-175. See, also, chart of *Mean Annual Precipitation* embracing the Maritime Provinces, p. 193. (A new edition is in course of publication). For precipitation records at St. John consult *Annual Report of City Engineer*, 1909, p. 116, where monthly averages are given for 49 years.

Later records may be found in the *Annual Report of the Meteorological Service of Canada.* (Central Office at Toronto.) Last report issued, Ottawa, 1911, is for the year 1907. Also, consult the *Monthly Weather Review* of the Meteorological Service, which gives tables of "Pressure, Temperature, Wind, and Precipitation of stations in the Dominion of Canada." The state of Maine has published rainfall records for forty-six stations, some of which are near the international boundary. See *First Annual Report, State of Maine Water Commission*, pp. 40-59.

† Consult chapter on *Evaporation*, in *First Annual Report, State of Maine Water Storage Commission*, pp. 60-63.

EVAPORATION RECORD STATIONS IN MAINE

Station	Location	Date Established	Date Discontinued
Soldier pond	Soldier pond	July 1, 1905	Nov. 7, 1908
Millinocket	Ferguson pond	July 1, 1905	Oct. 31, 1907
Lewiston	Androscoggin river	July 1, 1905	Oct. 31, 1907
Upper dam	Mooselucmaguntic lake	Aug. 19, 1905	Oct. 29, 1907

While the observations were not as continuous as could be desired, nevertheless, it is believed that they are fairly representative of the evaporation in the State, especially during the portion of the year which is most important regarding water storage. The results will be of interest when considering some New Brunswick waters. A summary of the results is given below. It will be seen that the average annual evaporation from water surface in Maine is about 26 inches, while in Boston the average is 39 inches.

AVERAGE MONTHLY EVAPORATION IN THE STATE OF MAINE

(*In inches*)

Month	Soldier Pond	Milli-nocket	Lewiston	Mooseluc-maguntic Lake	Composite Average	Average evapora-tion near Boston
January	.....	.....	1.0	.....	(0.7 ±)	0.98
February	.....	.....	.8	.....	(0.7 ±)	1.01
March	.....	.....	1.7	.....	(1.1 ±)	1.45
April	.....	.....	2.8	.....	(1.6 ±)	2.39
May	1.5	2.7	2.5	.....	(2.1)	3.82
June	2.5	2.8	3.3	.....	(2.8 ±)	5.34
July	3.9	4.8	5.3	3.3	4.32	6.21
August	4.6	5.7	5.2	4.5	5.00	5.97
September	2.9	3.8	3.6	3.0	3.32	4.86
October	2.2	2.7	2.3	2.2	(2.2)	3.47
November	.....	.....	1.3	.....	(1.3 ±)	2.24
December	.....	.....	0.7	.....	(0.7 ±)	1.38
Total	.....	.....	.....	.....	25.84	39.12

It would be an advantage to have some observations respecting evaporation made in the province of New Brunswick.

St. John River

The St. John river drains the largest basin between the St. Lawrence and Susquehanna rivers. Its headwaters lie in the mountainous region between Canada and Maine. From the junction of the North-west and South-west branches, where the river first takes its name, to its junction with St. Francis river, a distance of 90 miles, its course is, in general, north-eastward and lies wholly in Maine, although a portion of the tributary drainage area lies wholly in Canada. From its junction with the St. Francis, the St. John flows eastward, forming the international boundary for 70 miles, and receiving in this stretch two important tributaries—Fish river, from the south, at Fort Kent, and Madawaska river, from the north, at Edmundston. Above its intersection with the eastern boundary of Maine the drainage area of the St. John measures 8,765 square miles, of which 4,670 square miles are in Maine and 4,095 square miles in Canada. From source to mouth its length is about 450 miles, and its total drainage area measures about 26,000 square miles.

The ponds and lakes in the St. John basin have an aggregate area of about 314 square miles, the largest of these lakes being tributary to the Allagash and Fish rivers. On some of the lakes rough timber crib dams are used to store water for log driving, but little attempt is made to store water after the driving season is over. In the state of Maine previous to 1845, a canal was cut from Telos lake, in the Allagash river, to Webster lake, in the Penobscot basin, and a dam was constructed between Chamberlain and Eagle lakes. In this way Cumberland lake, with its drainage area of 270 square miles, was rendered, in part, tributary to the Penobscot. This diversion continues at the present time. Its general use is to supply water to the Penobscot during the log-driving season. After the gates at the dams are opened more water flows towards the St. John as the gate sills are 0.6 feet lower than those at Telos lake.*

The characteristics of the watershed of the St. John river, in many important particulars, resemble those of several of its tributaries. The basin above Grand falls is largely in forest. Above the Allagash, the river may be considered as rather closely resembling several New Brunswick rivers and the data for this portion of the St. John may, for the purposes of making deductions regarding run-off, etc., be regarded as of especial value. The general contour of the drainage surfaces, the density of the forests, and the low annual temperature, are factors, which, both in the main river and many of its branches, contribute towards retaining the precipitation so as to help eke out the low-water flow.

Precipitation records in the basin of the St. John are very meagre, but from the best information now available, it seems probable that the mean annual rainfall is not over 30 to 35 inches.

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* See *First Annual Report, State of Maine Water Storage Commission*, p. 76.

Photo by H. V. Henderson.]

TETAGOUCHE RIVER, NEW BRUNSWICK, FROM BLUFF OVERLOOKING TETAGOUCHE FALLS SHOWING GORGE CHARACTERISTIC OF MANY OF THE SMALLER STREAMS OF NEW BRUNSWICK

Photo by H. V. Henderson.]

GRAND FALLS, NIPISIGUIT RIVER, NEW BRUNSWICK

Reversible Falls.—The St. John river at its mouth has a restricted area, and the bed of the river has a ledge of rock from shore to shore. At the lower stages of the tide in the harbour, the river rushes over this ledge creating turbulent and unnavigable rapids. During the higher stages of the tide the flow is reversed. These features, coupled with the high tides, result in unique phenomena possessing latent water-power possibilities.

Schemes have been suggested for utilizing power from this "Reversible" fall, and some plan may yet be devised to take advantage of the power. No attempt, however, should be made to alter the natural conditions which now exist in the Reversible falls without the most mature consideration.

If we take the elevation of the bench mark at the Customs House as 100.00, low water in St. John harbour is 44.40, and high water, 71.40. Low water at Indiantown above the Reversible fall, is 59.53 and high water, 60.83.

Power Sites.—Upon the Upper St. John river and its tributaries there are a number of valuable power sites in the state of Maine. On the northerly international boundary there is a possible power sit at 'The Ledges.' After the river enters New Brunswick there is the well-known power site at Grand falls. Suggestions have been made that power developments may be created on the St. John respectively above the mouths of the Aroostook and Pokiok rivers. Such proposals, however, would require very careful consideration before being undertaken.

Elevations.—In this connection the elevations in feet above sea-level of the low-water surface of the St. John river are instructive. These, for some portions of the river, as taken by the International Commission Pertaining to the St. John River, are approximately as follows:*

ELEVATION OF ST. JOHN RIVER ABOVE SEA-LEVEL

(*In feet*)

Grand falls (Lower basin) 288.79	Tobique river, below mouth..... 221.78	Presquile, at mouth..144.98
Ortonville..... 262.61	Monquart river..... 166.74	Camel brook, mouth at Hale.....132.28
Salmon river..... 260.22	Shiktahawk river at mouth..... 159.78	Becaguimec river at mouth.....129.02
Aroostook river, near mouth..... 230.48	Below Florenceville . 151.75	Hartland, 2½ miles below.....119.51

* The datum is that of the National Transcontinental railway.

The following approximate low-water levels of the St. John river are selected from the survey made for the Department of Public Works, Canada, by C. Le B. Miles. The datum is the elevation of the Canadian Pacific railway at Woodstock, rail 136.00 (White's *Altitudes*). More complete data respecting levels on the St. John will be available as the result of surveys now (1911) being made by the engineers of the St. John River Commission.

WATER LEVELS, RIVER ST. JOHN

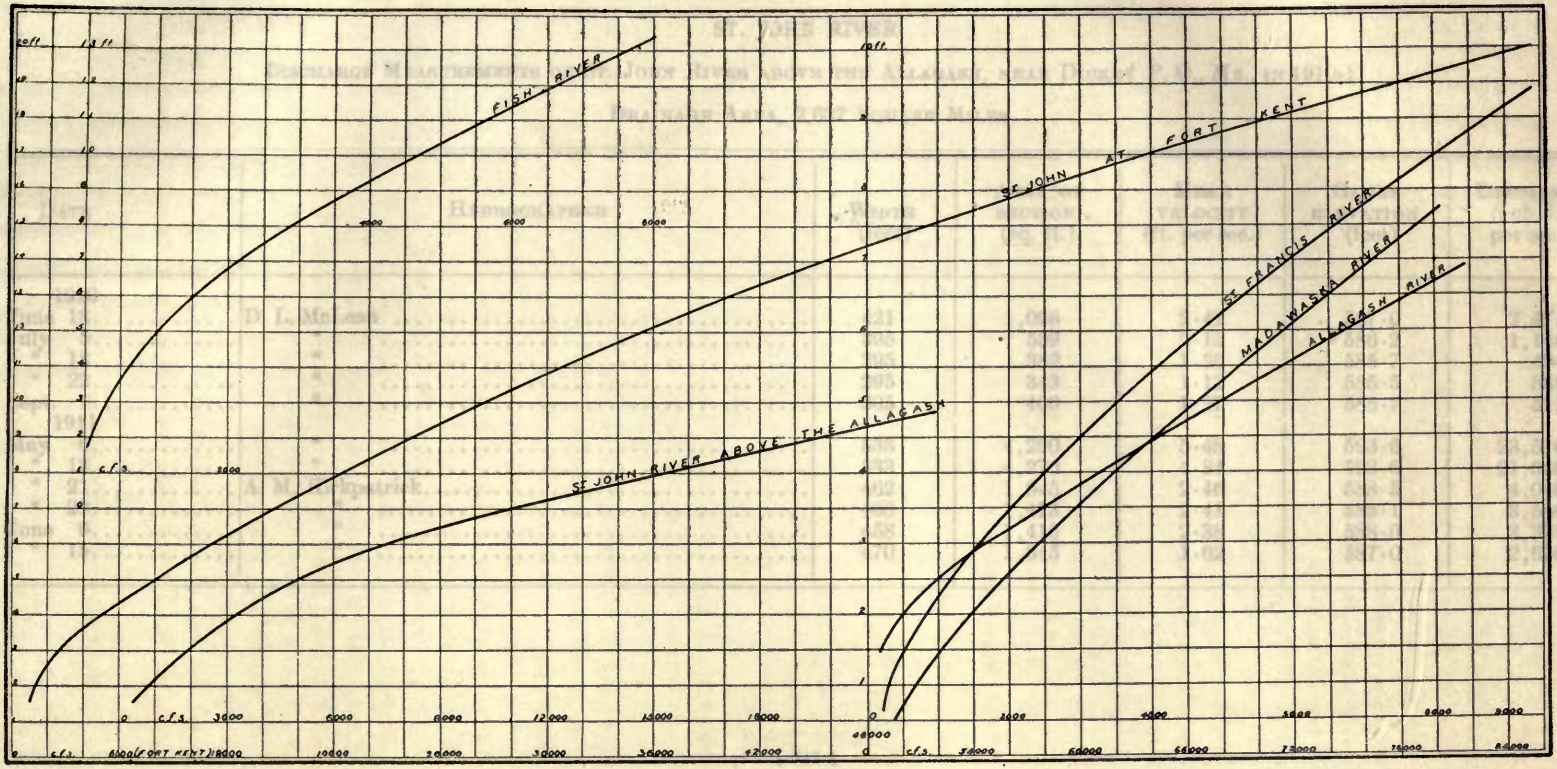
Station, Feet		Elevations, Feet	Station, Feet		Elevations, Feet
	Woodstock, near McElroy mill.....	98·00	100,500	Below the bar.....	56·26
34,676	Opposite Riordan island.....	82·40	104,400	Near the Governors Table.....	53·92
52,200	Where channel narrows.....	73·96	114,700	Head of Meductic falls.....	49·72
67,800	Near Meductic ferry	69·88	117,000	Foot of Meductic falls.....	44·80
85,000	At Patterson mill...	63·88	133,400	Opposite Pokiok stream.....	41·43
89,900	Near Hatfield ferry*	63·38	136,181	Hawkshaw bridge..	41·36
97,025	Near Belvisor bar...	61·36			

Discharge Data and Curves

There next follows a selection of data appertaining to the St. John river, and its larger tributaries above Grand falls. These data, which represent the chief component elements of the discharge at Grand falls, may be studied in connection with the diagram showing discharge curves of the upper St. John. In this diagram the zeros shown have been arbitrarily selected in order to enable the data to be presented on a single sheet. The zeros of the curves, therefore, must not be confounded with the zeros of the gauges erected upon the respective rivers. The actual *elevations* of the various water surfaces, above the National Transcontinental Railway datum† may be obtained from the vertical scales of the diagrams, by adding to each zero on the diagram its corresponding elevation above the National Transcontinental Railway datum as follows: St. John river above the Allagash, 584.00; Allagash, river 580.00; St. Francis river, 529.00; St. John river at Fort Kent, 486.70; Madawaska river, 475.50. Fish River zero is the Bench Mark of the United States Geological Survey, which is a copper bolt in the ledge near Wallagrass stream. Thus, by way of example, the numeral "6" above the zero on the Discharge Curve diagram for the St. John above the Allagash, corresponds to a water surface elevation of 584.00 + 6 = 590 feet above the National Transcontinental Railway datum; or, numeral "6" for the Madawaska to an elevation of 475.5+6=481.5 feet.

* Extreme freshet level, 84·56.

† Mean sea-level at Halifax.



CURVES SHOWING THE DISCHARGE OF UPPER ST. JOHN RIVER AND TRIBUTARIES

CURVES SHOWING THE DISCHARGE OF UPPER ST. JOHN RIVER AND TRIBUTARIES

ST. JOHN RIVER

DISCHARGE MEASUREMENTS OF ST. JOHN RIVER ABOVE THE ALLAGASH, NEAR DICKEY P. O., ME., IN 1910-11

DRAINAGE AREA, 2,627 SQUARE MILES

DATE	HYDROGRAPHER	WIDTH (feet)	AREA OF SECTION (sq. ft.)	MEAN VELOCITY (ft. per sec.)	GAUGE ELEVATION (feet)	DISCHARGE (cub. ft. per sec.)
1910						
June 18	D. L. McLean	421	1,028	2·41	587·0	2,471
July 5	"	395	539	2·13	586·2	1,146
" 18	"	295	382	1·30	585·7	495
" 22	"	295	343	1·13	585·5	388
Sept. 7	"	305	409	1·27	585·7	511
1911						
May 6	"	533	4,290	5·48	593·6	23,510
" 12	"	533	4,270	4·84	593·6	21,380
" 21	A. M. Kirkpatrick	462	1,645	2·46	588·5	4,040
" 29	"	460	1,473	2·41	588·1	3,550
June 6	"	458	1,416	2·38	588·0	3,378
" 15	"	470	1,645	1·62	587·0	2,670

ST. JOHN RIVER

DAILY GAUGE ELEVATIONS, IN FEET, ABOVE MEAN SEA-LEVEL,* OF THE ST. JOHN RIVER ABOVE THE ALLAGASH, NEAR DICKEY P. O., ME., FOR 1910†

ZERO OF GAUGE IS 584·41 FT. ABOVE MEAN SEA-LEVEL†

DAY	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1	.....	587·3	585·5	585·6	588·1	.....
2	.....	587·1	585·4	585·6	587·9	.....
3	.....	586·9	585·4	585·6	587·7	.....
4	.....	586·7	585·4	.....	587·0	.....
5	586·2	587·5	585·4	585·6	587·1	.....
6	586·1	587·5	585·5	585·7	588·1	.....
7	586·2	587·1	585·6	585·9	588·5	
8	586·2	587·0	586·4	586·4	588·8	.....
9	586·1	586·9	587·9	586·4	588·3	.....
10	586·0	586·5	588·1	586·9	587·7	.....
11	585·9	586·5	587·6	587·7	587·4	.....
12	585·9	587·0	587·2	587·2	587·1	.....
13	585·8	587·4	587·0	587·0	587·0	.....
14	585·8	587·7	586·7	586·3	586·7	.....
15	585·7	587·2	586·5	586·2	586·6	.....
16	585·7	586·7	586·5	586·1	586·4	.....
17	585·7	586·3	586·3	586·1	586·3	.....
18	585·6	586·1	586·1	586·2	586·2	.....
19	585·5	586·2	586·0	586·1	586·2	.....
20	585·4	586·4	585·9	586·3	586·2	.....
21	585·4	586·4	585·7	586·3	586·1	.....
22	585·5	586·2	585·6	586·2	586·1	.....
23	585·6	586·0	585·5	586·2	586·0	.....
24	585·8	585·9	585·5	586·1	587·9	.....
25	586·1	585·8	585·5	586·3	.....	.....

*As determined by the National Transcontinental Ry.

†Gauging station is located at L. V. Henderson's, between the Allagash and Little Black rivers.

Date		July	Aug.	Sept.	Oct.	Nov.	Dec.
26		586·3	585·7	585·5	586·3	.....	.....
27		586·6	585·7	585·5	586·9	.....	.....
28		586·8	585·7	585·5	587·3	.....	.....
29		587·6	585·6	585·6	587·4	.....	.....
30		587·7	585·6	585·6	588·0	.....	.....
31		587·7	585·5	.....	587·7	.....	.....

ALLAGASH RIVER, MAINE

DISCHARGE MEASUREMENTS OF THE ALLAGASH RIVER AT ITS MOUTH, in 1910-11
DRAINAGE AREA, 1,397 SQUARE MILES

Date	Hydrographer	Width (feet)	Area of section (sq. ft.)	Mean velocity (ft. per sec.)	Gauge elevation (feet)	Discharge (cub. ft. per sec.)
1910						
June 17	D. L. McLean	288	835	2·64	583·3	2,208
July 4	"	180	370	·70	581·5	258
" 16	"	247	511	1·29	582·2	661
" 21	"	109	166	1·57	581·7	259
1911						
May 5	"	340	1,850	4·39	586·8	8,125
" 11	"	305	1,566	4·12	585·9	6,467
" 20	"	289	1,050	3.77	584·0	3,960
" 29	A.M. Kirkpatrick	290	1,046	4·02	584·4	4,213
June 6	"	280	825	2·72	583·5	2,244
" 15	"	280	711	2·125	583·05	1,512

ALLAGASH RIVER, MAINE

DAILY GAUGE ELEVATIONS, IN FEET, ABOVE MEAN SEA-LEVEL,* OF THE ALLAGASH RIVER, AT ITS MOUTH, FOR, 1910
ZERO OF GAUGE IS 580·53 FT. ABOVE MEAN SEA-LEVEL

DAY	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1	.....	581·9	581·8	581·9	582·4	.....
2	.....	581·9	581·9	581·9	582·5	.....
3	.....	581·9	581·9	581·9	582·5	.....
4	.....	582·0	582·0	581·8	582·5	.....
5	.....	582·0	582·0	581·8	582·4	.....
6	.....	582·0	581·9	581·7	582·3	.....
7	.....	582·0	581·9	581·7	582·1	.....
8	.....	581·9	582·0	581·8	581·7	.....
9	.....	581·8	582·4	581·9	581·7	.....
10	.....	581·8	582·4	581·9	581·7	.....
11	.....	581·8	583·6	581·8	581·7	.....
12	.....	581·8	584·1	581·8	581·7	.....
13	.....	581·9	583·5	581·8	581·7	.....
14	.....	581·9	583·1	581·7	581·7	.....
15	.....	582·0	582·9	581·7	581·7	.....
16	.....	581·9	583·5	581·7	581·7	.....
17	.....	581·8	582·7	581·7	581·8	.....
18	.....	581·7	582·5	581·6	581·8	.....
19	.....	581·7	582·5	581·6	581·8	.....
20	.....	581·7	582·5	581·6	581·8	.....
21	581·6	581·7	582·4	581·6	581·7	.....
22	581·6	581·7	582·3	581·5	.....	.....
23	581·7	581·9	582·3	581·5	.....	.....
24	582·0	582·3	582·2	581·6	.....	.....
25	581·9	582·2	582·4	581·7	.....	.....
26	581·9	582·1	582·0	581·8	.....	.....
27	581·9	582·0	582·0	581·9	.....	.....
28	581·9	582·0	582·0	582·0	.....	.....
29	581·9	581·9	582·0	582·1	.....	.....
30	581·9	581·8	581·9	582·2	.....	.....
31	581·9	581·8	.....	582·2	.....	.....

*As determined by the National Transcontinental Ry.

ST. FRANCIS RIVER, NEW BRUNSWICK

DISCHARGE MEASUREMENTS OF THE ST. FRANCIS RIVER AT ITS MOUTH, NEAR CONNORS P. O., IN 1910-11
DRAINAGE AREA, 580 SQUARE MILES

DATE	HYDROGRAPHER	WIDTH (feet)	AREA OF SECTION (sq. ft.)	MEAN VELOCITY (ft. per sec.)	GAUGE* ELEVATION (feet)	DISCHARGE (cub. ft. per sec.)
1910						
June 15	D. L. McLean	110	376	3·16	554·6	1,188
July 1	"	100	237	1·90	553·5	461
" 14	"	96	205	1·64	553·2	336
" 24	"	94	179	1·21	553·0	216
Oct. 20	"	94	174	1·26	552·9	219
Nov. 24	"	96	207	1·60	553·2	331
1911						
May 4	"	.....	1,120	8·22	538·3	9,200
" 13	"	113·5	765	6·22	535·1	4,760
" 19	"	113·5	512	4·32	532·8	2,212
" 27	A. M. Kirkpatrick	113	343	3·18	531·4	1,090
June 5	"	112	333	3·11	531·3	1,036
" 14	"	105	260	2·22	530·5	578

* During 1910, the gauge was located at Morris; during 1911, at Harveys.

ST. FRANCIS RIVER, NEW BRUNSWICK

DAILY GAUGE ELEVATIONS, IN FEET, ABOVE MEAN SEA-LEVEL OF THE ST. FRANCIS RIVER, NEAR CONNORS, N. B., FOR 1910
ZERO OF GAUGE AT MORRIS, IS 549·46 FT. ABOVE MEAN SEA-LEVEL

DAY	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1	.....	.....	.....	.....	.....	555·7	553·5	553·5	552·7	552·6	553·2	
2	.....	.....	.....	.....	.....	555·7	553·4	553·5	552·7	552·6	553·2	
3	.....	.....	.....	.....	.....	555·7	553·4	553·6	552·6	552·6	553·1	
4	.....	.....	.....	.....	.....	555·7	553·4	553·6	552·6	552·6	553·1	
5	.....	.....	.....	.....	.....	555·6	553·4	553·5	552·6	552·6	553·1	
6	.....	.....	.....	.....	.....	555·6	553·4	553·5	552·6	552·6	553·2	
7	.....	.....	.....	.....	.....	555·4	553·4	553·5	552·7	552·6	553·4	
8	.....	.....	.....	.....	.....	555·2	553·5	553·5	552·7	552·7	553·5	
9	.....	.....	.....	.....	.....	555·1	553·5	553·4	552·7	552·7	553·8	
10	.....	.....	.....	.....	.....	555·0	553·4	553·3	552·7	552·7	554·0	
11	.....	.....	.....	.....	557·0	555·0	553·4	553·3	552·9	552·7	554·1	
12	.....	.....	.....	.....	557·0	554·9	553·3	553·3	552·9	552·8	554·1	
13	.....	.....	.....	.....	556·8	554·8	553·2	553·2	552·9	552·9	554·0	
14	.....	.....	.....	.....	556·5	554·7	553·2	553·2	553·0	552·9	553·9	
15	.....	.....	.....	.....	556·4	554·6	553·2	553·1	553·0	552·9	553·8	
16	.....	.....	.....	.....	556·0	554·6	553·2	553·1	553·0	552·9	553·8	
17	.....	.....	.....	.....	555·8	554·5	553·1	553·0	552·9	552·9	553·7	
18	.....	.....	.....	.....	555·5	554·4	553·1	553·0	552·9	552·9	553·7	
19	.....	.....	.....	.....	555·5	554·3	553·1	553·1	552·8	552·9	553·6	
20	.....	.....	.....	.....	555·8	554·2	553·1	553·1	552·8	552·9	553·6	
21	.....	.....	.....	.....	556·0	554·1	553·0	553·0	552·7	552·9	553·5	
22	.....	.....	.....	.....	555·7	554·0	553·0	553·0	552·7	552·9	553·5	
23	.....	.....	.....	.....	555·4	553·9	553·0	553·0	552·7	552·9	553·4	
24	.....	.....	.....	.....	555·3	553·9	553·0	552·9	552·7	552·9	553·3	
25	.....	.....	.....	.....	555·0	553·8	553·0	552·9	552·7	552·9	553·3	
26	.....	.....	.....	.....	555·0	553·7	553·1	552·9	552·7	552·9	553·3	
27	.....	.....	.....	.....	555·0	553·7	553·1	552·8	552·7	553·0	553·2	
28	.....	.....	.....	.....	555·0	553·6	553·2	552·8	552·6	553·0	553·2	
29	.....	.....	.....	.....	556·0	553·6	553·3	552·8	552·6	553·1	553·2	
30	.....	.....	.....	.....	555·5	553·5	553·3	552·8	552·6	553·1	553·2	
31	.....	.....	.....	.....	555·7	.....	553·4	552·7	.....	553·2	.....	

*As determined by the National Transcontinental Ry.

ST. JOHN RIVER

DAILY GAUGE ELEVATIONS, IN FEET, ABOVE MEAN SEA-LEVEL,* OF THE ST. JOHN RIVER AT FORT KENT, ME., IN 1910† ZERO OF GAUGE IS 486·70 FT. ABOVE MEAN SEA-LEVEL. DRAINAGE AREA, 5,280 SQUARE MILES.

DAY	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1	.....	.....	.....	.....	.....	493·7	490·6	491·4	.....	489·7	491·2	490·0
2	.....	.....	.....	.....	497·4	494·8	490·5	491·7	.....	489·7	491·2	490·0
3	.....	.....	.....	.....	497·2	495·3	.....	491·5	.....	489·7	491·2	490·0
4	.....	.....	.....	.....	497·8	394·9	.....	491·1	.....	489·7	491·5	.....
5	.....	493·1	492·4	496·2	498·0	.....	490·3	491·1	.....	489·7	492·6	490·8
6	.....	.....	.....	496·0	498·1	493·4	490·2	491·2	.....	489·8	493·5	491·0
7	.....	.....	.....	496·3	498·1	493·8	490·2	491·4	.....	490·2	494·4	491·2
8	.....	.....	.....	498·1	.....	493·8	490·2	491·2	.....	490·7	494·6	.....
9	.....	.....	.....	498·7	496·1	493·7	490·1	491·0	.....	491·1	494·3	.....
10	.....	.....	.....	.....	495·8	493·7	.....	490·8	.....	491·2	494·8	.....
11	.....	.....	.....	498·9	495·4	493·6	490·0	490·6	492·2	491·1	492·5	.....
12	.....	492·9	492·5	498·0	495·2	.....	489·9	490·6	492·0	490·8	491·7	.....
13	.....	.....	.....	497·2	494·9	493·2	489·9	490·7	491·9	490·5	.....	.....
14	493·4	.....	.....	496·6	494·5	493·1	489·9	490·9	491·5	490·3	491·4	.....
15	.....	.....	.....	495·8	.....	492·9	489·8	491·2	491·3	490·2	491·1	.....
16	.....	.....	.....	495·2	493·8	492·6	489·7	491·0	490·8	490·1	491·0	.....
17	.....	.....	.....	.....	493·6	492·4	.....	490·6	490·6	489·9	490·9	490·8
18	.....	.....	.....	495·1	493·3	492·3	490·0	490·4	.....	490·0	490·7	.....
19	.....	492·7	492·6	495·3	492·9	.....	490·1	490·4	490·8	490·3	490·7	.....
20	493·4	.....	.....	496·7	492·7	491·8	490·0	490·4	490·7	490·4	.....	.....
21	.....	.....	.....	498·8	492·5	491·6	490·0	490·4	490·5	490·2	490·6	.....
22	.....	.....	.....	500·4	.....	491·6	490·1	490·3	490·4	490·2	490·5	.....
23	.....	.....	.....	502·3	492·1	491·6	490·1	490·3	490·1	490·4	490·4	.....
24	.....	.....	.....	503·3	491·7	491·6	490·1	490·2	489·9	490·3	490·3	491·3
25	.....	.....	.....	502·8	491·9	491·6	490·2	490·3	489·7	490·2	490·2	.....

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
26	.....	.....	493·9	502·3	492·4	.....	490·5	490·2	489·7	490·2	490·2	.....
27	.....	.....	.....	502·0	492·8	491·3	490·6	490·1	489·7	490·5	.....	.....
28	.....	.....	.....	501·3	493·4	491·1	490·8	490·0	489·7	491·0	490·1	.....
29	.....	.....	.....	500.8	.....	490·8	491·0	490·0	489·7	491·1	490·1	.....
30	.....	.....	.....	499·8	493·0	490·6	491·1	489·9	489·7	.....	490·0	.....
31	.....	.....	.....	.....	493·2	.....	.....	489·9	.....	491·2	.....	.....

* As determined by the National Transcontinental Ry.

† This station is located at the foot bridge that crosses the St. John near Fort Kent P. O., a short distance above the confluence of the Fish river with the St. John. The gaugings here given have been taken by the State of Maine Water Storage Commission.

Data respecting the St. John river at Fort Kent, Me., will be found in the following: U. S. *Water Supply Papers;* for 1905, No. 165, pp. 21 to 24; for 1906, No. 201, pp. 23 to 25; for 1907 and 1908, No. 241, pp. 30 to 33. For discharge measurements consult No. 241, p. 31. The correspondence, or otherwise, between the zeros of the Water Storage Commission, and U. S. Geological Survey gauges should be ascertained before data collected by these organizations may, harmonoiusly, be correlated.

ST. JOHN RIVER

RUN-OFF OF ST. JOHN RIVER AT FORT KENT, ME., IN CUBIC FEET PER SECOND PER SQUARE MILE, AND DEPTH, IN INCHES
DRAINAGE AREA 5,280 SQUARE MILES

	1905		1906		1907		1908		1909		1910		Average	
	Feet per sec. per sq. mile	Depth in inches	Feet per sec. per sq. mile	Depth in inches	Feet per sec. per sq. mile	Depth in inches	Feet per sec. per sq. mile	Depth in inches	Feet per sec. per sq. mile	Depth in inches	Feet per sec. per sq. mile	Depth in inches	Feet per sec. per sq. mile	Depth in inches
January	.....	.....	.....	.....	·19	·22	·53	·61	·81	·94	·28	·32	·45	·52
February	.....	.....	.....	.....	·14	·15	·27	·29	·38	·39	·49	·51	·32	·34
March	.....	.....	.....	.....	·14	·16	·48	·55	·60	·69	·74	·86	·49	·56
April	.....	.....	4·41	4·92	1·27	1·42	1·47	1·64	2·80	3·12	5·98	6·67	3·17	3·55
May	.....	.....	4·55	5·25	7·54	8·69	7·80	8·99	7·82	9·02	3·09	3·56	6·16	7·10
June	.....	.....	1·34	1·50	2·95	3·29	3·05	3·40	1·35	1·51	1·67	1·86	2·07	2·31
July	.....	.....	·58	·67	2·25	2·59	·58	·66	1·63	1·88	·37	·42	1·08	1·24
August	.....	.....	·20	·23	1·09	1·26	·51	·55	·94	1·08	·53	·61	·65	·75
September	.....	.....	·10	·11	·61	·68	·17	·19	1·83	2·04	.....	.....	·68	·76
October	·26	·30	·48	·55	1·42	1·64	·20	·23	2·23	2·57	.....	.....	·92	1·06
November	·75	·84	·42	·47	2·75	3·07	·16	·17	1·18	1·32	.....	.....	1·05	1·17
December	.....	.....	.....	.....	1·17	1·35	·23	·26	·83	·95	.....	.....	·74	·85
Total	.....	.....	.....	.....	.....	24·52	.....	.....	.....	25·51	.....			20·21
Mean	.....	.....	.....	.....	1·79	.....	1·29	.....	1·87	.....	.....	.....	1·48	

FISH RIVER, MAINE

DISCHARGE MEASUREMENTS OF FISH RIVER AT U. S. GOVERNMENT STATION BELOW WALLAGRASS STREAM, IN 1910*
DRAINAGE AREA, 852 SQUARE MILES

DATE	HYDROGRAPHER	WIDTH (feet)	AREA OF SECTION (sq. ft.)	MEAN VELOCITY (ft. per sec.)	GAUGE ELEVATION (feet)	DISCHARGE (sec. ft.)
1911						
May 16		166	1,157	3·70	9·54	4,280
" 22		152	845	2·85	7·25	2,402
" 31		152	694	2·12	6·20	1,463
June 7		151	611	2·22	5·82	1,354
" 17		145	542	2·00	5·08	1,086

* Data respecting Fish river will be found in U. S. *Water Supply Papers* for 1903, No. 97, pp. 16 to 17; for 1904, No. 124, pp. 21 to 23, for 1905, No. 165, pp. 21 to 24; for 1906, No. 201, pp. 25 to 27; for 1907 and 1908, No. 241, pp. 33 to 36 and 342. See, also, No. 187, pp. 32 to 33, 39, 53 to 54, 73, 77, 82, 86 for a study of conditions under ice cover. See, also, Maine Water Storage Commission, *First Annual Report* p. 82, for a summary of run-off of Fish river from 1903 to 1909.

FISH RIVER, MAINE

DAILY GAUGE HEIGHT IN FEET, OF FISH RIVER AT WALLAGRASS, ME., FOR 1910. ZERO OF GAUGE IS B. M.* OF U. S. GEOLOGICAL SURVEY

DAY	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1	.....	3·5	2·4	2·3	2·4	
2	.....	3·4	2·3	.....	2·3	
3	.....	3·4	2·3	2·2	2·3	
4	.....	3·4	.....	2·2	2·4	
5	.....	3·4	2·2	2·2	2·4	
6	.....	3·3	2·2	2·1	.....	
7	.....	.....	2·2	2·2	3·0	
8	.....	3·3	2·2	2·1	3·3	
9	.....	3·2	2·4	.....	3·3	
10	.....	3·2	2·5	2·0	3·2	
11	.....	3·2	.....	2·0	3·2	
12	.....	3·2	2·5	2·0	3·2	
13	3·7	3·0	2·5	1·9	.....	
14	3·9	3·0	2·5	1·9	3·4	
15	4·0	2·9	2·6	1·9	3·4	
16	3·9	2·8	2·6	.....	3·4	
17	.....	2·8	2·6	1·9	3·4	
18	3·7	2·8	.....	1·9	3·5	
19	3·7	2·9	2·5	2·3	3·5	
20	3·6	2·8	2·5	2·2	.....	
21	3·6	2·8	2·3	2·0	3·4	
22	3·6	2·8	2·2	2·1	3·4	
23	3·5	2·8	2·2	.....	3·4	
24	.....	2·7	2·2	2·0	3·4	
25	3·7	2·6	.....	2·0	3·4	
26	3.7	2·6	2·2	2·1	3·3	
27	3·7	2·6	2·2	2·4	.....	
28	3·6	.....	2·2	2·3	3·3	
29	3·6	2·5	2·3	2·3	3·4	
30	3·6	2·5	2·3	.....	3·4	
31	.....	2·4	.....	2·4	.....	

*Copper bolt in ledge near Wallagrass stream.

MADAWASKA RIVER, QUEBEC

DISCHARGE MEASUREMENTS OF THE MADAWASKA RIVER AT STE. ROSE, P. Q., NEAR FOOT OF TEMISCOUATA LAKE, IN 1910-11

DRAINAGE AREA, 962 SQUARE MILES

DATE	HYDROGRAPHER	WIDTH (feet)	AREA OF SECTION (sq. ft.)	MEAN VELOCITY (ft. per sec.)	GAUGE ELEVATION (feet)	DISCHARGE (sec. ft.)
1910						
June 13	D. L. McLean	.....	.....	.....	479·0	3,440
" 24	"	.....	.....	.....	478·1	1,950
July 8	"	.....	.....	.....	477·2	1,145
" 23	"	.....	.....	.....	476·6	784
Oct. 20	"	.....	.....	.....	476·1	480
" 22	"	60	222	1·80	476·0	400
Nov. 26	"	221·4	1,539	·73	476·9	1,120
1911						
May 4	"	221·4	2,570	2·29	480·3	5,900
" 10	"	227·0	2,845	2·65	483·2	7,560
" 18	"	219·5	2,648	2·60	482·6	6,883
" 26	A. M. Kirkpatrick	221·5	2,404	2·07	480·8	4,986
June 3	"	221·5	2,143	1·72	479·7	3,695
" 13	"	221·5	1,879	1·31	478·5	2,464

MADAWASKA RIVER, QUEBEC

DAILY GAUGE ELEVATIONS, IN FEET, ABOVE MEAN SEA-LEVEL* OF THE MADAWASKA RIVER AT STE. ROSE, P. Q., NEAR FOOT OF TEMISCOUATA LAKE, FOR 1910
ZERO OF GAUGE IS 475·70 FT. ABOVE MEAN SEA-LEVEL.

DAY	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1	.....	479·5	477·4	476·9	476·1	475·9	476·3	476·8
2	.....	479·5	477·3	476·9	476·0	475·9	476·3	476·8
3	.....	479·6	477·3	476·8	476·0	475·9	476·3	476·8
4	.....	479·4	477·2	476·8	476·0	475·9	476·3	476·7
5	.....	479·3	477·2	476·8	476·0	475·9	476·4	476·7
6	.....	479·3	477·1	476·8	476·1	475·9	476·5	476·7
7	.....	479·2	477·2	476·8	476·1	475·9	476·6	476·7
8	.....	479·2	477·2	476·7	476·0	475·9	476·6	476·7
9	.....	479·2	477·1	476·7	476·1	475·9	476·7	476·7
10	.....	479·1	477·1	476·7	476·1	475·8	476·7	476·7
11	.....	479·1	477·1	476·6	476·1	475·8	476·8	476·7
12	483·1	479·0	477·1	476·6	476·1	475·8	476·8	476·7
13	482·8	479·0	477·1	476·5	476·1	475·8	476·9	476·7
14	482·6	478·9	477·1	476·5	476·1	475·9	476·9	476·7
15	482·3	478·8	477·0	476·5	476·1	475·9	476·9	
16	482·0	478·7	477·0	476·5	476·0	476·0	476·9	
17	481·8	478·6	476·9	476·4	476·0	476·2	476·9	
18	481·5	478·5	476·9	476·5	476·0	476·1	476·9	
19	481·3	478·4	476·8	476·5	476·0	476·1	476·9	
20	481·1	478·4	476·7	476·4	476·0	476·1	476·9	
21	580·9	478·3	476·6	476·4	476·0	476·0	476·9	
22	580·7	478·3	476·6	476·3	476·0	476·0	476·9	
23	480·4	478·2	476·6	476·3	476·0	476·1	476·8	
24	580·2	478·1	476·6	476·3	476·0	476·1	476·8	
25	480·1	478·0	476·6	476·3	476·0	476·1	476·9	
26	580·0	477·9	476·7	476·3	476·0	476·2	476·9	
27	480·1	477·8	476·6	476·2	476·0	476·2	476·9	
28	579·9	477·7	476·6	476·2	475·9	476·3	476·8	
29	579·8	577·6	576·7	476·2	475·9	476·3	476·8	
30	479·7	477·5	476·7	476·1	475·9	476·3	476·8	
31	579·6	.....	476·9	476·1	.....	476·3	.....	

*As determined by the National Transcontinental Ry.

Aroostook River

The Aroostook river is the largest tributary of the St. John. Its drainage area of 2,350 square miles is nearly all in the state of Maine. The United States Geological Survey, since 1903, has maintained a gauging station at the steel highway bridge in the village of Fort Fairfield, Me., about three miles from the international boundary line.* The power development at Aroostook falls is just over the boundary in New Brunswick. On account of the comparative lack of storage facilities upon the Aroostook, and its resemblance in some marked features to some of New Brunswick's rivers, results obtained at Fort Fairfield may profitably be studied as illustrative of the regimen of such rivers. During the low-water season, which frequently occurs in both the fall and midwinter, its flow has been known to reach a minimum of .06 cubic feet per second per square mile, a remarkably low figure for such a stream in the East.

AROOSTOOK RIVER, MAINE

RUN-OFF OF AROOSTOOK RIVER AT FORT FAIRFIELD, MAINE., IN FEET PER SECOND PER SQUARE MILE, AND DEPTH, IN INCHES
DRAINAGE AREA, 2,230 SQUARE MILES

	1903		1904		1905		1906		1907		1908		1909		1910		AVERAGE	
	Feet per sec. per sq. mile	Depth in inches	Feet per sec. per sq. mile	Depth in inches	Feet per sec. per sq. mile	Depth in inches	Feet per sec. per sq. mile	Depth in inches	Feet per sec. per sq. mile	Depth in inches	Feet per sec. per sq. mile	Depth in inches	Feet per sec. per sq. mile	Depth in inches	Feet per sec. per sq. mile	Depth in inches	Feet per sec. per sq. mile	Depth in inches
Jan.	.....	.....	.....	.....	.....	.....	.....	.....	·36	·41	·67	·78	·67	·77	1·47	1·70	·79	·92
Feb.	.....	.....	.....	.....	.....	.....	.....	.....	·22	·23	·60	·65	·61	·64	1·53	1·59	·74	·78
Mar.	.....	.....	.....	.....	.....	.....	.....	.....	·31	·36	·77	·89	·77	·88	1·03	1·19	·72	·83
Apr.	.....	.....	.....	.....	.....	.....	7·31	8·16	2·08	2·32	3·07	3·42	6·32	7·05	7·40	8·26	5·24	5·84
May.	.....	.....	8·93	10·30	.....	.....	8·25	9·51	7·76	8·95	7·98	9·20	7·40	8·53	4·22	4·86	7·42	8·56
June	.....	.....	1·64	1·83	1·18	1·32	1·79	2·00	2·76	3·08	2·75	3·07	1·08	1·20	2·35	2·62	1·94	2·16
July.	.....	.....	·82	·94	·35	·41	·72	·83	2·40	2·77	·36	·41	1·63	1·88	1·32	1·52	1·09	1·25
Aug.	·29	·33	·33	·38	·13	·15	·28	·32	2·32	2·68	·38	·44	1·23	1·42	·30	·34	·66	·76
Sept.	·21	·24	1·34	1·49	·08	·09	·11	·13	1·03	1·15	·16	·18	2·66	2·97	.....	.....	·80	·89
Oct.	·10	·11	1·50	1·73	·07	·08	1·40	1·61	1·41	1·63	·19	·22	3·05	3·52	·19	·22	·99	1·14
Nov.	·41	·46	·60	·67	·18	·20	·78	·87	2·71	3·02	·24	·27	2·19	2·44	·59	·66	·96	1·07
Dec.	·33	·38	·64	·74	.....	.....	1·32	1·52	1·83	2·11	·22	·26	1·62	1·87	·57	·66	·93	1·08
Total.	.....	.....	.....	.....	.....	.....	.....	.....	.....	28·71	.....	19·79	.....	33·17	.....	.....	.....	25·28
Mean.	.....	.....	.....	.....	.....	.....	.....	.....	2·10	.....	1·45	.....	2·43	.....	.....	.....	1·86	

* *Re* Aroostook river, consult, U. S. *Water Supply Papers*, for 1903, No. 97, pp. 17-18; for 1904, No. 124, pp. 23-26; for 1905, No. 165, pp. 24-27; for 1906, No. 201, pp. 27-28; for 1907 and 1908, pp. 36-39 and 342. See, also, *Ibid.*, Plate III, which gives the Discharge, Area, and Mean Velocity curves for the Aroostook river at Fort Fairfield, Me., See also, *First Annual Report*, State of Maine Water Storage Commission, pp. 82-83.

St. Croix River

The St. Croix river, including the East branch, also known as the Upper St. Croix, forms nearly half of the boundary between the province of New Brunswick and the state of Maine. The total drainage area is 1,630 square miles, the East branch having 690 square miles and the West branch, at their junction, 670 square miles.

The mean annual precipitation is probably about 41 inches, varying from 44 inches at Eastport, on the coast, to 38 inches in the northern portions. The St. Croix, owing to its extensive lake system, which comprises about one-tenth of the total drainage area, has an unusually uniform flow. Since 1905, the United States Geological Survey have maintained a gauging station near Woodland, Me., about one and a half miles downstream from Sprague falls.* The station is about ten miles below the junction of the West with the East branch, and about fourteen miles above the mouth of the St. Croix river.

ST. CROIX RIVER, MAINE

RUN-OFF OF ST. CROIX RIVER NEAR WOODLAND, ME., IN FEET PER SECOND PER SQUARE MILE, AND DEPTH, IN INCHES. DRAINAGE AREA, 1420 SQ. MILES

	1903		1904		1905		1906		1907		1908		1909		1910		AVERAGE	
	Feet per sec. per sq. mile	Depth in inches	Feet per sec. per sq. mile	Depth in inches	Feet per sec. per sq. mile	Depth in inches	Feet per sec. per sq. mile	Depth in inches	Feet per sec. per sq. mile	Depth in inches	Feet per sec. per sq. mile	Depth in inches	Feet per sec. per sq. mile	Depth in inches	Feet per sec. per sq. mile	Depth in inches	Feet per sec. per sq. mile	Depth in inches
Jan. . .	4·65	5·36	.....	.....	.....	.....	.....	.....	1·23	1·42	1·90	2·19	1·64	1·89	1·75	2·02	2·53	2·58
Feb. . .	3·60	3·75	.....	.....	.....	.....	.....	.....	·68	·71	1·27	1·37	1·11	1·16	1·73	1·80	1·68	1·76
Mar. . .	5·53	6·37	.....	.....	.....	.....	.....	.....	·96	1·10	4·55	1·79	1·81	2·09	2·05	2·36	2·98	2·74
Apr. . .	3·48	3·88	4·34	4·84	3·26	3·64	.....	.....	2·20	2·46	2·37	2·64	5·24	5·85	2·06	2·30	3·28	3·66
May. . .	1·59	1·83	5·05	5·82	1·79	2·06	3·29	3·79	3·30	3·80	3·68	4·24	3·30	3·80	1·87	2·16	2·98	3·44
June. .	1·82	2·03	1·87	2·09	1·63	1·82	2·18	2·43	2·98	3·32	2·46	2·74	1·63	1·82	1·87	2·09	2·06	2·29
July. .	1·95	2·25	2·22	2·56	2·26	2·61	1·70	1·96	2·42	2·79	1·06	1·22	1·42	1·58	1·42	1·64	1·81	2·08
Aug. . .	1·32	1·52	1·08	1·24	1·00	1·15	1·48	1·71	2·32	2·68	1·27	1·46	1·41	1·63	1·46	1·68	1·42	1·63
Sept. . .	·52	·58	·82	·92	·68	·76	·81	·90	2·20	2·46	1·06	1·18	2·94	3·28	1·43	1·60	1·31	1·46
Oct. . .	·52	·60	·98	1·13	·39	·45	1·42	1·64	1·74	2·01	·88	1·01	3·09	3·56	1·34	1·54	1·30	1·49
Nov. . .	·74	·83	·79	·88	·53	·59	1·63	1·82	1·78	1·99	·70	·79	1·82	2·03	·89	1·00	1·11	1·24
Dec. . .	1·32	1·52	1·02	1·18	.....	.....	1·44	1·66	2·06	2·38	·63	·73	1·51	1·74	·95	1·10	1·28	1·47
Total. .	.....	30·52	.....	.....	.....	.....	.....	.....	.....	27·12	.....	21·36	.....	30·43	.....	21·29	.....	25·84
Mean. .	2·25	.....	.....	.....	.....	.....	.....	.....	1·99	.....	1·57	.....	2·24	.....	1·57	.....	1·98	

*Re St. Croix River, consult, U. S. *Water Supply Papers*, for 1902, No. 82, p. 14; for 1903, No. 97, pp. 20–23; for 1904, No. 124, pp. 27-30; for 1905, No. 165, pp. 28-30; for 1906, No. 201, pp. 29-31; for 1907 and 1908, No. 241, pp. 41-43, and 342. Also, consult, State of Maine, Water Storage Commission, *First Annual Report*, pp. 84-91. Also, *Water-Powers of Maine*, (U. S. *Water Supply Paper*, No. 69) pp. 20-27.

ST. JOHN RIVER, NEW BRUNSWICK

DAILY GAUGE HEIGHTS, IN FEET, FOR THE ST. JOHN RIVER, IN UPPER BASIN, GRAND FALLS, N. B., FOR 1908-09-10

ZERO OF GAUGE IS ASSUMED AS 216·3, WHICH CORRESPONDS TO AN ELEVATION, IN FEET, OF 405·01, ABOVE MEAN SEA-LEVEL AS DETERMINED BY THE NATIONAL TRANSCONTINENTAL RY.*

DAY	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1908												
1	.....	217·8	.....	219·1	232·3	229·5	221·1	217·9	217·2	216·0	216·0	216·4
2	.....	.....	218·9	219·3	233·6	229·5	221·0	217·6	217·0	216·0	216·0	216·5
3	.....	217·8	218·9	.....	233·6	229·5	220·9	217·3	217·0	216·1	215·9	216·9
4	220·1	217·8	218·7	219·4	232·1	229·2	220·7	217·1	216·8	216·4	216·0	216·0
5	.....	217·8	218·6	.....	232·7	227·6	220·5	217·0	216·7	216·8	216·1	216·0
6	219·9	217·8	218·4	219·5	232·5	226·5	220·4	217·2	216·6	217·1	216·1	216·3
7	219·7	217·7	218·4	.....	232·1	225·7	220·5	217·8	216·5	217·0	215·0	216·5
8	.....	217·7	.....	.....	232·4	225·0	220·7	217·9	216·7	216·8	215·8	216·4
9	.....	217·6	218·3	219·5	232·5	224·8	220·7	218·0	216·5	216·8	216·0	216·4
10	220·0	217·5	218·2	219·3	232·5	224·4	220·5	218·1	216·4	216·6	216·2	216·3
11	.....	217·4	218·1	.....	232·3	223·9	220·4	218·0	216·3	216·4	216·1	216·3
12	.....	217·4	218·0	.....	231·9	223·6	220·2	217·9	216·3	216·2	216·0	216·2
13	.....	217·4	217·9	219·5	232·0	223·3	220·1	217·8	216·2	216·0	216·1	216·4
14	.....	217·3	217·9	.....	232·1	222·9	219·9	217·8	216·1	216·3	216·1	216·4
15	.....	217·3	.....	219·6	232·5	222·6	219·8	217·8	216·0	216·4	216·2	216·3
16	.....	218·9	218·1	219·9	232·5	223·1	219·7	218·4	216·0	216·3	216·2	216·4
17	.....	219·0	218·4	.....	232·3	223·6	219·6	218·2	215·9	216·3	215·9	216·4
18	219·0	218·9	.....	220·2	232·2	223·9	219·2	218·4	215·8	216·3	215·7	216·3
19	.....	218·9	218·5	.....	232·4	224·1	218·9	218·6	215·9	216·3	215·5	216·2
20	219·0	218·9	.....	220·4	232·4	224·6	218·8	218·8	215·8	216·2	215·5	216·4
21	.....	219·0	218·6	220·4	232·4	225·1	218·7	219·5	215·6	216·2	215·4	216·3
22	218·6	219·1	.....	220·4	231·4	225·5	218·5	219·8	215·9	216·1	215·3	216·4
23	218·8	219·2	.....	.....	230·6	225·2	218·4	219·8	215·9	216·1	215·3	216·4
24	218·6	219·3	218·7	220·7	229·8	224·6	218·4	219·3	215·8	216·1	215·6	216·3
25	218·4	219·3	.....	221·0	229·1	223·9	218·4	218·8	215·8	216·0	215·8	216·3

* The gauge readings, above given, may be converted into gauge elevations above sea-level, (N. T. Ry.) by adding 188·71.

ST. JOHN'S RIVER, NEW BRUNSWICK—*Continued*

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
26	218·3	219·3	218·9	.....	220·3	223·4	218·3	218·4	215·7	215·9	215·8	216·3
27	218·2	219·2	218·9	222·6	227·7	223·0	218·3	218·1	215·6	216·0	216·0	216·2
28	218·2	219·2	.....	223·6	227·9	222·6	218·2	218·0	215·5	216·3	216·1	216·3
29	218·2	219·1	.....	226·6	228·0	222·2	218·0	217·6	215·7	216·3	216·4	216·2
30	218·1	.....	218·9	229·5	227·9	221·6	218·0	217·5	215·9	216·2	216·4	216·1
31	218·1	.....	219·0	.....	228·7	.....	217·9	217·2	.....	216·1	.....	215·9
1909												
1	215·8	216·1	216·4	217·0	224·4	224·8	220·3	220·6	221·4	227·0	220·2	221·0
2	215·6	216·1	216·3	216·9	224·5	224·0	220·2	220·6	221·2	226·5	220·2	221·4
3	215·6	216·0	217·1	217·1	224·8	223·5	220·2	220·3	221·3	225·5	220·1	221·7
4	215·6	216·0	217·1	217·1	224·6	223·0	220·8	219·3	221·3	224·8	220·1	221·6
5	215·7	216·1	217·2	217·1	224·1	222·9	221·0	219·0	222·4	224·3	222·0	221·4
6	216·4	216·2	217·2	217·2	224·4	222·6	221·3	218·6	222·5	223·8	220·0	221·4
7	216·3	216·5	217·3	217·6	224·8	222·4	221·8	218·3	222·8	223·4	219·9	221·2
8	216·2	216·4	217·3	218·3	224·5	222·2	221·9	218·0	222·8	223·0	219·9	221·0
9	216·2	216·4	217·1	218·9	227·3	222·0	221·8	218·3	222·5	222·6	219·9	221·0
10	216·1	216·3	217·1	219·1	228·5	221·8	221·9	.....	222·2	222·0	219·8	220·9
11	216·1	216·3	217·2	219·1	231·8	221·3	221·6	.....	221·8	221·5	219·7	220·9
12	216·3	216·2	217·2	219·8	234·6	221·2	220·7	.....	221·4	221·0	219·6	220·8
13	216·3	216·2	217·2	220·1	236·9	221·1	221·0	217·3	221·3	220·8	219·6	220·7
14	216·2	216·3	217·1	220·9	236·7	221·3	221·3	218·0	221·0	221·0	220·0	220·5
15	216·1	216·3	217·1	222·2	235·4	221·1	221·0	218·5	220·8	220·9	220·2	220·5
16	216·0	216·3	217·0	222·5	234·7	221·1	221·0	219·7	220·6	221·0	220·3	220·2
17	215·9	216·3	217·0	222·5	234·5	221·5	221·3	219·3	220·5	220·8	220·4	220·2
18	215·9	216·2	216·7	223·0	234·2	221·8	221·5	219·5	220·3	220·6	220·4	220·0
19	215·9	216·3	216·7	223·1	233·8	222·3	221·8	219·1	220·0	220·4	220·2	220·0
20	215·8	216·3	216·6	223·3	233·2	222·9	222·1	218·9	219·9	220·4	220·1	220·1

21	215·7	216·2	216·7	224·0	232·1	223·4	221·9	218·8	219·8	220·4	220·1	220·2
22	215·7	216·2	216·7	224·1	231·0	223·0	222·1	218·6	219·6	220·3	220·2	220·1
23	215·7	216·2	216·6	224·5	229·8	222·3	221·8	218·4	219·4	220·5	220·2	220·0
24	215·6	216·3	216·5	224·8	229·5	220·0	221·4	218·2	219·6	220·5	220·1	219·9
25	215·5	216·5	216·5	224·9	229·3	221·8	221·3	218·0	219·8	220·4	220·2	219·8
26	215·5	216·5	216·6	225·6	228·3	221·4	221·2	219·0	220·0	220·4	220·3	219·7
27	215·5	216·4	216·8	225·9	226·6	221·0	221·0	220·7	220·7	220·3	220·3	219·5
28	215·5	216·4	217·1	225·1	226·3	220·7	220·9	221·8	220·8	220·3	220·3	219·3
29	215·7	.....	217·1	224·8	225·8	220·5	221·0	222·1	222·8	220·3	220·6	219·0
30	215·8	.....	217·1	224·6	225·4	220·5	220·7	222·4	226·1	220·2	220·7	218·9
31	216·0	.....	217·0	.....	225·0	.....	220·7	221·9	.....	220·2	.....	218·8
1910												
1	218·5	218·0	219·0	219·8	225·1	223·5	218·8	217·0	216·5	215·8	218·8	.....
2	218·3	217·9	218·9	220·0	225·0	224·5	218·8	217·0	216·3	215·7	219·1	.....
3	218·0	217·8	218·9	220·1	225·8	225·6	218·7	217·0	216·0	215·8	219·6	.....
4	217·6	217·8	218·9	220·2	224·6	225·4	218·7	217·2	215·8	215·9	220·0	.....
5	218·4	217·8	218·8	222·3	224·4	224·6	218·6	217·7	215·6	216·0	220·2	.....
6	219·5	217·7	218·7	223·4	224·0	223·5	218·5	218·0	215·4	216·1	220·4	.....
7	220·6	217·8	218·9	224·1	223·8	223·1	218·4	218·2	215·3	216·0	220·7	.....
8	220·4	217·7	218·8	224·5	223·5	223·5	218·3	218·1	215·5	216·0	221·5	.....
9	220·3	217·7	218·9	224·7	223·2	223·3	218·3	218·0	215·7	216·1	221·4	.....
10	220·2	217·7	218·7	224·7	222·9	223·1	218·2	217·9	215·6	216·2	221·1	.....
11	219·9	217·6	218·7	225·1	223·4	222·8	218·2	217·8	215·8	216·1	220·9	.....
12	219·2	217·5	218·6	224·8	223·6	222·6	218·1	217·7	216·0	216·2	220·6	.....
13	218·8	217·4	218·6	224·6	224·1	222·7	218·2	217·6	216·3	216·2	220·4	.....
14	218·5	217·3	218·7	224·4	224·8	222·7	218·0	217·6	.....	216·3	220·1	.....
15	219·1	217·2	218·7	224·8	225·5	222·3	217·9	218·0	.....	216·4	220·0	.....
16	219·4	217·2	218·7	224·0	224·9	222·0	217·8	218·0	.....	216·5	219·8	.....
17	219·3	217·1	218·7	225·0	224·5	221·6	217·8	218·2	.....	216·7	219·7	.....
18	219·3	217·0	218·7	224·9	223·8	221·4	217·7	218·1	.....	216·7	219·7	.....
19	219·2	217·0	218·7	224·8	223·4	221·2	217·7	218·0	.....	216·6	219·6	.....
20	219·2	217·2	218·6	224·7	223·1	221·0	217·7	217·9	.....	216·3	219·4	.....

ST. JOHN'S RIVER, NEW BRUNSWICK—*Continued*

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
21	219·2	217·3	218·6	224·5	222·9	220·9	217·6	217·8	.....	216·2	219·2	.....
22	219·1	217·5	218·5	224·3	222·7	220·8	217·6	218·7	.....	216·2	219·0	.....
23	219·0	217·6	218·6	224·2	222·4	220·7	217·8	218·6	.....	216·7	219·0	.....
24	218·9	217·7	218·6	224·0	221·9	220·6	217·9	218·5	.....	217·5	219·0	.....
25	218·8	217·9	218·6	223·6	221·4	220·4	217·8	218·3	.....	218·0	219·0	.....
26	218·7	218·3	218·6	223·4	221·7	220·0	217·7	217·9	.....	218·3	219·1	.....
27	218·6	218·5	218·7	224·0	221·9	219·6	217·7	217·6	.....	218·6	219·2	.....
28	218·6	219·0	218·9	224·2	223·7	219·5	217·6	217·4	.....	218·8		.....
29	218·4	.....	219·2	224·4	224·1	219·3	217·4	217·2	.....	218·8		.....
30	218·2	.....	219·4	224·6	223·8	219·0	217·3	217·0	.....	218·8		.....
31	218·1	.....	219·6	.....	223·4	.....	217·2	216·7	.....	218·8		.....

ST. JOHN RIVER, NEW BRUNSWICK

RATING TABLE, GRAND FALLS, N. B.*

Gauge height	Discharge	Gauge height	Discharge	Gauge height	Discharge	Gauge height	Discharge	Gauge height	Discharge	Gauge height	Discharge
215 00	1,300	218 00	4,350	221 00	13,200	224 00	27,600	227 00	45,300	230 00	62,800
10	1,375	10	4,400	10	13,650	10	28,200			231 00	68,600
20	1,450	20	4,650	20	14,100	20	28,800	20	46,460	232 00	74,500
30	1,525	30	4,775	30	14,550	30	29,400			233 00	80,300
40	1,600	40	5,000	40	15,000	40	30,000	40	47,620	234 00	86,200
50	1,675	50	5,125	50	15,450	50	30,600			235 00	92,000
60	1,750	60	5,350	60	15,900	60	31,200	60	48,780	236 00	97,900
70	1,825	70	5,575	70	16,350	70	31,800				
80	1,900	80	5,750	80	16,800	80	32,400	80	49,940		
90	1,975	90	5,975	90	17,250	90	33,000				
216 00	2,050	219 00	6,200	222 00	17,700	225 00	33,600	228 00	51,100		
10	2,150	10	6,425	10	18,150	10	34,200				
20	2,250	20	6,650	20	18,600	20	34,800	20	52,270		
30	2,350	30	6,825	30	19,050	30	35,400				
40	2,450	40	7,200	40	19,500	40	36,000	40	53,440		
50	2,550	50	7,500	50	19,950	50	36,600				
60	2,650	60	7,800	60	20,400	60	37,200	60	54,610		
70	2,750	70	8,150	70	20,850	70	37,800				
80	2,850	80	8,500	80	21,300	80	38,400	80	55,780		
90	2,950	90	8,850	90	21,750	90	39,000				
217 00	3,050	220 00	9,200	223 00	22,200	226 00	39,600	229 00	56,950		
10	3,175	10	9,600	10	22,650	10	40,000				
20	3,300	20	10,000	20	23,100	20	40,600	20	58,020		
30	3,425	30	10,400	30	23,600	30	41,250				
40	3,550	40	10,800	40	24,100	40	41,700	40	59,290		
50	3,675	50	11,200	50	24,650	50	42,300				
60	3,800	60	11,600	60	25,200	60	42,900	60	60,460		
70	3,925	70	12,000	70	25,800	70	43,500				
80	4,050	80	12,400	80	26,400	80	44,100	80	61,630		
90	4,200	90	12,800	90	27,000	90	44,700				

*This table is applicable for open channel conditions.

DRAINAGE AREA 8279 SQUARE MILES

Month	Discharge in cubic feet per second				
	Maximum	Minimum	Mean	Per square mile	Run off depth in inches on drainage area
1908					
January	9600	4400	6074	.734	.85
February	6825	3300	5086	.614	.64
March	6200	4200	5192	.627	.72
April	59870	6425	14826	1.791	2.00
May	83840	49360	70649	8.534	9.84
June	59870	15900	32657	3.944	4.40
July	13650	4200	8223	.993	1.12
August	8500	3050	4710	.569	.66
September	3300	1675	2248	.272	.30
October	3175	1975	2361	.285	.33
November	2450	1300	2013	.243	.27
December	2950	1975	2525	.305	.35
The year	83840	1300	13047	1.576	21.48
1909					
January	2450	1675	1976	.239	.28
February	2550	2050	2318	.280	.29
March	3425	2350	2993	.362	.42
April	39000	2950	17663	2.134	2.38
May	103120	28200	58417	7.056	8.13
June	32400	11200	18042	2.180	2.43
July	18150	10000	14200	1.715	1.98
August	19500	3425	8166	.986	1.14
September	40000	7200	14516	1.753	1.96
October	45300	10000	17389	2.100	2.42
November	12000	7800	9707	1.172	1.31
December	16350	5750	10900	1.317	1.52
The year	103120	1675	14691	1.774	24.46
1910					
January	11600	3800	6504	.786	.91
February	6200	3050	3900	.471	.49
March	7800	5125	5770	.697	.80
April	34200	8500	26825	3.240	3.62
May	38400	15000	26019	3.143	3.62
June	37200	6200	18444	2.228	2.49
July	5750	3300	4390	.530	.61
August	5575	2750	4056	.490	.56
September	2550	1525	1933	.234	.26
October	5750	1750	2963	.358	.41
November	15450	5750	9052	1.093	1.22
December	.....	.....	.....	.....	
The year	38400	1525	9987	1.206	14.99

*For number of days entering into the determination of the *means* consult tables of gauge heights, above.

Sources and Character of Tabular Data

The column headed "Approximate area of watershed in square miles" gives the areas as measured from the best available maps.* Later maps of portions of New Brunswick are in preparation, and will permit more accurate measurements of watershed areas to be made.

The column headed "Approximate head in feet" gives, sometimes, the natural head, sometimes, the possible head, and, sometimes, the developed head. The statements made under the column of "Remarks" must be considered in connection with the column relating to head. Wherever possible, the heads were measured by instrumental, or by hand levelling, but, in many instances, the data were supplied in answer to enquiry sent by mail. On this account considerable allowance must be made for the "personal factor." Although discretion has been exercised in sifting the data, yet, generally speaking, the heads given must be regarded only as approximations.

The column headed "Estimated low water 24-hours horse-power for 8 months" may be explained as follows:† Numerically considered, the majority of New Brunswick's water-power sites would practically be inoperative for at least three to four months of the year, namely, during the summer and early fall. In considering the situation as a whole, it has been concluded that the power possibilities of New Brunswick's waters, from the standpoint of usability, may more fairly be presented in tables on an eight, than on a twelve months' basis. The eight months' column, therefore, gives the *estimated* least amounts of water-power that may be obtained continuously for eight months of the year. In most instances, and, especially in the cases of the smaller streams, the estimated quantities of power given in the tables could not be obtained without the special utilization of storage. On the other hand, at certain seasons of the year, much more power than is indicated may be developed. If, in addition to such general storage facilities as each individual case demands, additional means exist for locally storing the flow for, say, twelve hours, then, practically double the listed horse-power would be available for the other ten or twelve hours of the day. The column gives *theoretical* quantities of horse-power. In practice, only from sixty-five to eighty per cent. of the theoretical horse-power is recoverable and, with the limited data at hand, it is not possible to differentiate between the various powers. In such a list some powers may be over-estimated, others, under-estimated.

* The principal maps of New Brunswick are as follow: *Topographical Sheet of New Brunswick*, No. 13, (Dept. of Interior, Ottawa), includes the whole of N. B. with exception of Madawaska and portions of Westmorland and Albert counties. For Madawaska, see *Serial Sheets*, and other maps published by Geological Survey of Canada, listed in *Catalogue of Publications; Map of the Province of New Brunswick*, by T. G. Loggie, 1885, scale 4 m. 1 in.; *Map of the Province of New Brunswick*, by T. G. Loggie, 1907, scale, 10 m. = 1 in.; *Map of the Maritime Provinces*, (Mackinlay), 1910, scale, 7.63 m. = 1 in.

† For description of methods adopted in preparing tables, consult pp. 19-21.

Allowances have not been made for the requirements of log driving. In a word, the *estimated, theoretical* quantities of horse-power, given in the fourth column, simply indicate the magnitude of the power possibilities at the respective water-power sites. If powers are to be dealt with individually, and for special purposes, then data are demanded of a more precise and special nature than those here given.*

NEW BRUNSWICK†

DISTRICT NO. IV—SOUTHWESTERN NEW BRUNSWICK

	Site	Approximate area of watershed (in square miles)	Approximate head (in feet)	Estimated low-water 24-hour H.P. for 8 months. (Theoretical)	Remarks
St. Croix river:‡ (Main river).....		.....	.....	.....	
	Todd dam....	1,630	8–12	2,550	Saw mill on both banks, at head of tide; also electric light station developing 500 H.P.
	Salmon fall ..	1,530	21	5,480	Canadian Cotton Mills Co., Ltd.; three 54-inch Hercules turbines installed; about 1,100 H.P. actually in use 0
740.	Milltown (Murchie & Son's mill)..	.....	9	450	On U. S. side, saw and planing mill. A wing dam diverts only a portion of the water in the river; about 450 H.P. developed
	Milltown Eaton Dam	1,530	12	3,130	Eaton's saw mills on both sides of river
	Baring dam..	1,420	8–10	2,180	Old saw mill site 5 miles below Sprague; said to have 12 ft. fall from pond to foot of rips below the dam
741.	Sprague fall. ...	1,390	46	10,900	14,350 H.P. developed by the St. Croix Paper Co., (U. S. A.)
	Grand falls (Lower pitch)	1,360	15–20	4,000	Similar to upper pitch, and about half a mile below it
742.	Grand falls (Upper pitch)	1,360	15–20	4,000	Just below mouth of West branch. Abrupt fall of 6 ft., also heavy rapids below

* Respecting the use of auxiliary plants see, above p. 205

† This list is not complete for the power sites of New Brunswick. Although every effort was made, it was not possible, in the time available, to obtain satisfactory data respecting some rivers, as, for example, the Restigouche and parts of the Miramichi. Such additional data may be made available should more comprehensive survey in the field be undertaken.

‡ For discharge data respecting St. Croix river see table above.

DISTRICT NO. IV—SOUTHWESTERN NEW BRUNSWICK—*Continued*

Site	Approximate Area of Watershed (in square miles)	Approximate Head (in feet)	Estimated low-water 24-hour H.P., 8 months. (Theoretical)	Remarks
St. Croix river:				
(East branch) ..	690	20	2,190	Located two miles above mouth of West branch
743. Spedic falls.....	.....	.....	.....	
744. Canoose rips....	660	11	1,150	Fall of 11 ft. in about half mile; 12 miles below Little fall
745. Little fall	500	3–4	270	High banks at dam site; 3 to 4 ft. fall in 300 or 400 ft.; 8 miles below Vanceboro
Old tannery dam.....	420	8	535	Abandoned site; tannery destroyed by fire
746. Vanceboro storage dam...	420	13·5	900	Controlling storage dam at foot of Chiputneticook lakes
Porter Mill stream:				
747. Maritime Edge Tool Co.....	40	20	65	90 H.P. developed
Bocabec river:				
748. Saw mill dam ..	12	20	19	Sawmill
Digdeguash river:				
749. Mouth of river..	181	30	430	Possible dam site.
750. Rolling mill dam	144	13	150	About 20 miles from mouth
Lintern river:				
756. Mill dam.....	40	6–8	22	Saw mill near Bonney river
Magaguadavic river:				
751. St. George fall .	688	45	3,500	3,000 H.P. developed by St. George Pulp Co.
Second fall ...	572	12	780	Gillmor Bros. saw mill; possible, 18-20 ft.
752. McDougall fall	552	16	1,000	About 5 miles above Gillmor dam; 16 ft. fall in about 500 ft.; high rocky banks
753. Little fall	468	6	320	About 6 miles above McDougall fall
754. Magaguadavic Lake dam....	150	9	150	

DISTRICT No IV—SOUTHWESTERN NEW BRUNSWICK—*Continued*

	Site	Approximate area of watershed (in square miles)	Approximate head (in feet)	Estimated low-water 24-hour H.P. for 8 months. (Theoretical)	Remarks
	Magaguadavic river:				
	(N. E. branch)				
	D. Little, mill dam.....	48	18	70	Excelsior mill
755.	York woollen mill dam...	48	18–20	70	Grist mill; also woolen and carding mill
	R. Little, mill dam.....	40	15	48	Saw mill
	Lepreau river:				
	First fall	90	50	350	At tidewater; possible dam site
757.	Big fall	90	80–90	600	Log-driving dam. Fall in about 500 ft
	Ragged fall ..	76	80	480	80 ft. fall in about ¼ mile; possible dam site
758.	Forks dam....	63	8	40	
759.	Victoria Lake dam	20	10	16	
	Musquash river:				
	(West branch)				
	Mill dam.....	76	15	100	Abandoned mill site, about 1½ miles from forks
760.	Big fall	76	30	200	Dam site; high rocky banks
	Musquash river:				
	(N. E. branch)				
	Mill dam.....	68	22	135	Head might be increased 10-15 ft.
	First roll.....	68	8	50	High rocky banks 50-60 ft. high
761.	Second roll...	68	10	60	High rocky banks, 50-60 ft. high
	Loch Alva dam.....	51	20-30	115	Head might be obtained by crossing rocky ridge between lake and river

DISTRICT No. V—SOUTHEASTERN NEW BRUNSWICK

Site	Approximate area of watershed (in square miles)	Approximate head (in feet)	Estimated low-water 24-hour H.P. for 8 months. (Theoretical)	Remarks
Mispec river:				
762. Mispec fall	52	60	.....	Owned by city of St.John only surplus water available for power purposes; at present in use by pulp mill
Little river:				
763. Silver fall	16	30·8	.....	Partly owned by city of St. John, only surplus water available for power purposes
Salmon river:				
764. First dam.....	108	29	250	Saw mill. Fall of 29 ft. in about ⅜ mile above dam
Scadouac river:				
765. Electric Co. dam	31	25	55	Shediac Elec. Lt. & Pr. Co.
Cocagne river: (Kent co.)				
766. Lockhart dam ..	50	17	58	Possible 24 feet. Old saw mill site; 6 miles above mouth
Kouchibouguacis river:				
767. McLeod mills ..	112	18	135	Former saw mill site Possible 24 ft. head
Kouchibouguac river:				
768. Atkinson & Sullivan dam site	144	50	490	High rocky banks, said to be possible head of 100 ft. due to rapid fall of river
Bay-du-Vin river: (Northumberland co.)				
769. Old dam.....	88	30	180	Old dam site, about 8 or 9 miles above mouth

DISTRICT No. VI—MIRAMICHI RIVER AND TRIBUTARIES

Site	Approximate area of watershed (in square miles)	Approximate head (in feet)	Estimated low-water 24-hour H.P. for 8 months. (Theoretical)	Remarks
Barnaby river:				
770. Saunders dam...	192	40	520	Old mill dam, about half-mile above mouth
Sabbie river:				
771. Underhill dam..	80	30	160	Abandoned mill dam,.. about 9 miles above mouth of Cain bridge
N. W. Millstream:				
772. Old mill dam...	76	28	145	Possible dam site near mouth of N. W. Miramichi
Southwest Miramichi:				
773. Grey rapids...	2,032	30	5,000	Possible dam site
773. Doctor island	1,800	10–15	2,000	Possible dam site at Blackville
Renous river:				
774. Possible dam site	280	30	660	Possible dam site, 3 to 7 miles above Indian town
Bartholomew river:				
775. Old saw mill site.	152	15	180	At Blackville; former saw and grist mill
Taxes river:				
776. Old mill site....	196	30	460	Abandoned mill dam
Burntland Brook:				
777. Grist mill dam..	56	10	38	Head, it is said, might be increased to 20 ft.
Little S. W. Miramichi:				
778. Red Stone rapids	544	30	1,400	Possible dam site near mouth of Catamaran brook
779. Beachy rapids	308	30	800	Possible dam site
779. Rocky island.	300	20	500	Possible dam site; rapids
780. Mains ledges....	276	20–25	550	Possible dam site
North Pole branch:				
781. Falls.....	60	20–30	100	About half-mile above mouth
Northwest Miramichi:				
782. The Falls.....	116	60	470	Possible dam site; dam, it is said, might be about 100 ft. high
Sevogle river: (North branch)				
783. Sevogle fall	84	30	170	Fall of 10 ft.; possible 30 ft. head, about one mile above the "Square Forks"

DISTRICT No. VII—NORTHERN NEW BRUNSWICK

Site	Approximate area of watershed (in square miles)	Approximate head (in feet)	Estimated low-water 24-hour H.P. for 8 months. (Theoretical)	Remarks
Caraquet river:				
784. Walker dam....	70	16–18	95	At Burnsville; possible 25 ft. head
Nipisiguit river:				
785. Pabineau fall ...	730	25	1,600	Fall in about 1,200 ft.
786. Midlanding rapids.....	716	30	1,900	Fall is about ⅓ mile; high rocky banks
787. Chain-of-rocks rapid	658	35	2,000	Fall in about ½ mile; high rocky banks
787. Grand fall and rapids .	644	00–125 1	6,500	Falls, 57-85 ft.: rapids below falls have descent of 30-40 ft.
788. The Narrows....	628	30	1,700	Possible head of 50-60 ft
789. Indian fall	344	.....	.....	
Tetagouche river:				
790. Browns dam .	152	12	145	Might be raised to 35 ft., one mile below Bathurst
790. Bathurst Elec. Co. dam....	148	24	280	Might be raised to 50 ft.; 300 H.P. developed
Jacquet river:				
791. Dam at mouth. .	160	12	150	Proposed dam
Charlo river:				
792. Falls on N. branch.....	72	40	225	Possible dam site, 3 miles above forks
792. Falls on S. branch.....	60	18–25	105	Possible dam site; 1 mile from mouth
Upsalquitch river:				
793. Little fall	872	18	1,250	Actual fall 8 ft.; high banks
794. Big fall	800	25	1,600	Actual fall 6 ft.; high banks
795. Southeast fall...	320	25	640	Actual fall 8 ft; high banks
Restigouche river:*				
796.	.....	.....	.....	

* At the date of publication, data for the Restigouche river could not be obtained. Owing to the lateness of the season, it was not practicable to prosecute field-work in this territory.

DISTRICT No. VIII—ST. JOHN RIVER AND TRIBUTARIES

Site	Approximate area of watershed (in square miles)	Approximate head (in feet)	Estimated low-water 24-hour H.P. for 8 months. (Theoretical)	Remarks
Belleisle creek:				
797. Northrop mill dam.....	32	26	47	Saw mill, about 4 miles from mouth
797. Sharpe mill dam.....	30	26	44	Grist mill, about 7 miles from mouth
Smith river:				
798. Oldfield mill dam	76	26	110	Grist mill; possible 50 ft. head, about 2 miles from junction
799. Pierce mill dam.	60	26	88	Saw and grist mill, about 5 miles from junction
800. Robinson mill dam.....	34	25	48	Saw mill, about 8 miles from junction
Newcastle creek:				
801. Mill dam.....	78	10	44	Saw and grist mill
Nerepis river:				
802. Fowler fall.....	175	5	50	Near Nerepis; low banks, meadow land
803. Jones creek: Near mouth..	20	20	22	Possible dam site
803. Flaglor brook: Falls near mouth.....	20	20	22	Possible 40 ft. head; rocky banks
Oromocto river: (*South branch*)				
804. So. Branch falls.	160	22	280	10 miles from mouth; head might be increased to about 40 ft.
Oromocto river: (*North branch*)				
805. Near Tracey....	212	20–25	350	Fall of 23 ft. in 3 miles from Fredericton junction to Tracey
Nashwaak river:				
806. Marysville mill dam.....	660	25	1,100	
807. Douglas mill dam	236	8	125	At Stanley
Cross creek:				
808. Robbin mill dam	64	10	40	

DISTRICT No. VIII—ST. JOHN RIVER AND TRIBUTARIES—*Continued*

Site	Approximate area of watershed (in square miles)	Approximate head (in feet)	Estimated low-water 24-hour H.P. for 8 months. (Theoretical)	Remarks
Nacawic river:				
809. Mouth of river..	172	20	230	Old mill site
810. Temperance Vale mill dam.....	92	26	160	Saw and grist mill. Said to be a drop of about 130 feet in 2 miles above dam
Pokiok river:				
Factory dam to St. John river.....	82	100	650	Head of 28 ft., now utilized for sash and door factory by Gilman and Burden
811. The Narrows..	70	100	560	Fall of 100 ft. in about half a mile
Shogomoc river:				
812. Dam at mouth..	100	70–90	700	It is stated that a 16 ft. dam on ledge above highway bridge would give 90 feet head in about 1,500 feet
Eel river:				
813. White mill.....	224	10	200	Saw and grist mill. Possible 40-50 ft. head
814. Eel River falls..	160	50	700	Near Benton. Possible dam site
Meduxnekeag river:				
815. First dam.....	520	13	500	Grist mill, 275 H.P. developed
815. Woodstock Electric Co.	520	27–32	1,100	600 H.P. developed for light and power
816. Oakville mill dam.....	160	15	190	On N. W. Branch; Briggs' saw mill
Little Presquile river:				
Waterville mill	56	14	54	About 3 miles from mouth; saw mill
817. Clark mill dam	48	10	33	About 4 miles from mouth; grist mill
Burpee mill dam.....	48	10	33	About 5 miles from mouth; saw mill
Carvill grist mill dam...	28	19	37	About 10 miles from mouth; grist mill
818. Williamstown lake dam...	28	15	29	About 10 miles from mouth; saw mill

DISTRICT No. VIII—ST. JOHN RIVER AND TRIBUTARIES—*Continued*

Site	Approximate area of watershed (in square miles)	Approximate head (in feet)	Estimated low-water 24-hour H.P. for 8 months. (Theoretical)	Remarks
Becaguimec river:				
819. Near mouth of river.....	208	20	280	Possible dam site about one mile from mouth; rocky banks; said to be about 50 ft. high
Presquile river:				
820. Sherwood dam..	156	17	180	At Centreville; grist mill 50 H.P. plant, lights Centreville
Shiktahawk river:				
821. Saw mill dam...	76	9	39	About 3 miles from mouth
Monquart river:				
822. Dam at mouth .	68	8	31	Saw mill; might be increased to 20 ft. head
Des Chutes river:				
823. Mill dam.....	28	80	125	Saw mill, Miller Bros
Muniake river:				
824. Dam at mouth..	21	19	21	Saw mill
Tobique river:				
825. The Narrows....	1,728	30	5,000	High rocky banks; 30 ft. would back the water up about 3½ miles
826. Red rapid	1,656	10	1,600	Possible dam site
827. Fraser mill dam.	1,276	5–10	1,000	At Plaster Rock, Fraser Bros. have a 5 ft. dam It might be raised to 10 ft.—possibly more
Pokiok stream: (branch of Tobique)				
828. Sadler mill dam.	32	46	80	At mouth
Otella river:				
829. Fall	20	90	100	Fall of 90 ft. in about half a mile; bottom is ledge; steep banks about 8 miles from mouth
Odell river:				
830. Sluice fall	20	60	68	Fall of 60 ft. in about 400 ft; on Right Hand branch, half a mile above forks; good banks
Big fall	16	80	72	3 miles above Sluice falls
Black Jaws...	12	25	17	3 miles above Big falls

DISTRICT No. VIII—ST. JOHN RIVER AND TRIBUTARIES—*Continued*

Site	Approximate area of watershed (in square miles)	Approximate head (in feet)	Estimated low-water 24-hour H.P. for 8 months. (Theoretical)	Remarks
Sisson branch:				
831. Sisson falls.....	90	80	490	High banks
Right-hand branch:				
832. Fall	340	50	1,600	Fall of 25 ft., 50 ft. fall in about ¾ mile
Serpentine river:				
833. McCarty fall ...	148	40	470	Fall, 15 ft.; 40 ft. descent in about half a mile; 4 miles from mouth;. Good banks
834. Big fall	100	45	350	Fall, 15 ft.; 45 ft. in about half-a-mile. Banks fair. About 8 miles from mouth
834. Little fall	92	55	400	Descent of 10 ft. in about half a mile; banks fair; about 2 miles above Big fall
Aroostook river:*				
835. Aroostook fall ..	2,280	77	13,000	1800 H.P. developed by the Maine and New Brunswick Electric Power Co.: proposed to add 2,000 H.P. unit
Limestone river:				
836. First three falls.....	80	94	500	Partly owned by municipalities of Perth and Andover
836. Edwards mill dam	80	21	100	Grist mill
Little river: (Enters St. John at Grand fall)				
837. Burgess dam....	146	12	120	Burgess saw mill
Grand river:				
838. Michaud dam...	164	10	110	Abandoned mill site; near mouth
Green river:†				
839. Mill dam	544	15	650	Saw mill; at mouth of rivers; might be increased to 25 ft.

* For discharge data respecting the Aroostook river, see Table, page 255

† On June 22nd, 1910, the discharge of the Green river was 910 cubic feet per second, with a drainage area of 215 square miles above the metering station.

DISTRICT No. VIII ST. JOHN RIVER AND TRIBUTARIES—*Continued*

	Site	Approximate area of watershed (in square miles)	Approximate head (in feet)	Estimated low-water 24-hour H.P. for 8 months. (Theoretical)	Remarks
840	Emmerson farm.	496	15–20	690	Being developed (1911)
841.	Foot of First lake.....	104	20	166	Possible dam site; rocky banks
	Dam site.....	212	20	330	Possible dam site on right hand branch, above forks
Iroquois river:					
842.	Saw mill dam.	75	12	60	At highway bridge
	Rosseau dam.	67	20	90	Saw mill, about 5 miles up
Madawaska river:*					
843.	Murchie dam ...	1,090	12–15	1,600	Saw mill at Edmundston
Baker brook:					
844.	Fraser mill dam.	170	12	180	Saw mill, at mouth
845.	Foot of Baker lake.....	22	15	30	Possible dam site
Little river:					
846.	Pelky mill.....	40	12	27	Saw mill
St. Francis river:†					
847.	Foot of Glasier lake.....	539	30	1,200	Possible dam site
848.	Outlet of Cross lake.....	357	23	800	Possible dam site, known as the "Mill Privilege;" exceptional natural site for storage reservoir
St. John river:‡					
849.	Pokiok site.....	14,600	20	33,000	Proposed site of the St. John River Electric Power Co.
850.	Grand fall	5,280	120–130	120,000	Natural fall 119½ ft.; fall itself is 74 ft.; descent in chasm 45½ ft.; contemplated developed head, 130 ft.
851.	"The Ledges"..	5,280	15	9,000	Rocky banks, but there is a possibility of flooding improved properties

* For discharge data respecting the Madawaska river, see Table on page 253
† For discharge data respecting the St. Francis river, see Table on page 247
‡ For discharge data respecting the St. John river see tables above. It has been proposed to erect a dam at a site about 750 feet above Grand falls. The proposed dam will give a head of 130 and its crest will be at about elevation 232 (Grand Falls Power Co. datum). The storage in the head waters of the St. John river will greatly enhance the value of power sites upon this river. Part of this storage would be required to produce the quantities of estimated power given in the table.

CHAPTER VIII

Water-powers of Manitoba, Saskatchewan, Alberta, Yukon and North West Territories

Owing to the paucity of information available, it has not been possible to do more than refer briefly to the more immediately accessible powers in Manitoba, Alberta, Saskatchewan, British Columbia, North West Territories and Yukon. Statements without any reliable basis have been made respecting the powers in these provinces and territories but, with a few exceptions, they can only be characterized as guesses. Information of a more exhaustive character will, however, be prepared at the earliest date possible and published as a report on the Water-powers of Western Canada. The brief reports herein published will serve as a reconnaissance of the more accessible powers of the Prairie Provinces and British Columbia, pending the collection of more complete information.

THE rivers and streams of Manitoba, Saskatchewan, Alberta, North West Territories, the Railway Belt and the Peace River Block of British Columbia are under the control of the Dominion Government. The disposal and use of the water-powers in Manitoba, Saskatchewan, Alberta, North West Territories and the Peace River Block* are regulated by Section 35 of the Dominion Lands Act, 1908, and by regulations established thereunder by Orders in Council. These regulations were also made applicable to water-powers in Dominion Forest Reserves and Parks by an Order in Council of June 6, 1911. Litigation regarding jurisdiction over the water-powers in the Railway Belt has resulted in Federal control of the powers in that section being upheld and legislation governing their disposal is now (July, 1911) before the Dominion Parliament.† Irrigation in Saskatchewan, and Alberta is regulated by the Irrigation Act (R.S.C., 1906, chap. 61).

The application of the foregoing acts and regulations is under the direction of the Minister of the Interior.

Laws and Regulations

Regulations under the Dominion Lands Act

Section 35 of the Dominion Lands Act provides as follows:

35. Land required for the development of any water-power shall only be sold or leased under regulations made by the Governor in Council.

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*For the text of Bill 124, "A Bill relating to the water in the Railway Belt and Peace River Block of land," see chap. X.

†The above-mentioned bill—No.124—it will be noted, also makes provision for the disposal of water-powers in the Peace River Block.

2. Subject to rights which exist or may be created under *The Irrigation Act*, the Governor in Council may make regulations: (a) for the diversion, taking or use of water for power purposes, and the granting of the right to divert, take and use water for such purposes, provided that it shall be a condition of the diversion or taking of water that it shall be returned to the channel through which it would have flowed if there had been no such diversion or taking, in such manner as not to lessen the volume of water in the said channel; (b) for the construction on or through Dominion or other lands of sluices, races, dams or other works necessary in connection with such diversion, taking or use of water; (c) for the transmission, distribution, sale and use of power and energy generated therefrom; (d) for the damming of and diversion of any stream, watercourse, lake or other body of water for the purpose of storing water to augment or increase the flow of water for power purposes during dry season; (e) for fixing the fees, charges, rents, royalties or dues to be paid for the use of water for power purposes, and the rates to be charged for power or energy derived therefrom.

3. Any person who under such regulations is authorized to divert, take or use water for power purposes, or to construct works in connection with the diversion, taking or use of water for such purposes, shall for the purposes of his undertaking have the powers conferred by *The Railway Act* upon railway companies, including those for the acquisition and taking of the requisite lands, so far as such powers are applicable to the undertaking and are not inconsistent with the provisions of this Act or the regulations thereunder, or with the authority given to such person under such regulations,—the provisions of the said Railway Act giving such powers being taken for the purposes of this section to refer to the undertaking of such person where in that Act they refer to the railway of the railway company concerned.

4. All maps, plans and books of reference showing lands other than Crown land necessary to be acquired by any such person for right-of-way or other purposes in connection with his undertaking shall be signed and certified correct by a duly qualified Dominion land surveyor.

5. Such maps, plans and books of reference shall be prepared in duplicate, and one copy thereof shall be filed in the office of the Minister at Ottawa, and the other shall be registered in the land titles office for the registration district within which the lands affected are situated.

6. The Minister, or such officer as he designates, shall in case of dispute be the sole and final judge as to the area of land which may

City of Winnipeg Power Plant, Point du Bois, Winnipeg River, Manitoba

be taken by any person without the consent of the owner for any purpose in connection with any water power undertaking.

Under the present regulations, the application for a license must go through three distinct stages before the license is finally granted. These may be briefly summarized as follows: First, the applicant, having obtained the necessary information regarding the proposed development, applies to the Minister for the license, his application being accompanied by a description of the site and proposed works. Second, if the Minister approves of the works, he then enters into an agreement with the applicant for a license, by which the latter is allowed to proceed with the construction of the works. Third, when the works are completed and the Minister is satisfied that the terms of the agreement have been fulfilled, he then issues the license to the applicant.

Following is the text of the regulations now in force:—

1. Under these regulations the word "works" shall be held to mean and include all sluices, races, dams, weirs, tunnels, pits, slides, flumes, machines fixed to the soil, buildings and other structures for taking, diverting and storing water for power purposes, or for developing water-power and rendering the same available for use.

Application for License

2. Every applicant for a license to take and use water for power purposes shall file with the Minister of the Interior a statement in duplicate setting forth:

(a) The name, address and occupation of the applicant.

(b) The financial standing of the applicant so far as it relates to his ability to carry out the proposed works.

(c) The character of the proposed works.

(d) The name, or if unnamed, a sufficient description of the river, lake or other source from which water is proposed to be taken or diverted.

(e) The point of diversion.

(f) The height of the fall or rapid of such river, lake or other source of water at high, medium and low stages, with corresponding discharges of water per second, reckoned approximately in cubic feet.

(g) A reasonably accurate description, and the area, of the lands required in connection with the proposed works, such lands, if in surveyed territory, to be described by section, township and range, or river or other lot, as the case may be, and a statement whether such lands are or are not Dominion lands.

(h) If such lands be not Dominion lands, then the applicant shall give the name of the registered owner in fee, and of any registered mortgagee or lessee thereof, and of any claimant in actual possession other than a registered owner, mortgagee or lessee.

(i) The minimum and maximum amount of water-power which the applicant proposes to develop, and the maximum amount of water which he desires for such purpose.

(j) Sketch plan showing approximate locations of the proposed works.

(k) Elevations of head water and tail water of the nearest existing works, if any, below and above the proposed works.

(l) Particulars as to any water to be taken, diverted or stored to the detriment of the operation of existing works, if any.

(m) Particulars as to any irrigation ditches or reservoirs, or other works for irrigation within the meaning of the *Irrigation Act*, in use or in course of construction within the vicinity of the proposed works, and which might affect or be affected by the operation of the proposed works.

3. If the applicant be an incorporated company, the statement shall, in addition to the foregoing information, set forth:

(a) The name of the company.

(b) The names of the directors and officers of the company, and their places of residence.

(c) The head office of the company in Canada.

(d) The amount of subscribed and paid-up capital, and the proposed method of raising further funds, if required, for the construction and operation of the proposed works.

(e) Copy of such parts of the charter or memorandum of association as authorize the application and proposed works.

4. If the applicant be a municipality, then, excluding the special information to be given by a company, the following information shall be given:

(a) The location, area and boundaries of the municipality.

(b) The approximate number of its inhabitants.

(c) The present estimated value of the property owned by such municipality, and the value of the property subject to taxation by such municipality.

5. The Minister of the Interior shall have the power to call for such other plans and descriptions, together with such measurements, specifications, levels, profiles, elevations and other information as he may deem necessary, and the same shall be furnished by and at the expense of the applicant.

Agreement for a License

6. Upon receipt and consideration of the application, and information accompanying same, the Minister of the Interior may, if he approve of the proposed works, enter into an agreement with the applicant, which agreement, in addition to usual conditions and covenants, shall contain clauses to provide as follow:

(a) For a time within which the proposed works shall be begun.

(b) For a stated minimum amount of expenditure to be made in connection with the works annually during the term of the agreement.

(c) For a stated amount of water-power to be developed from the water applied for within a fixed period not exceeding five years.

(d) For summary cancellation of the agreement by the Minister if any of the above conditions have not been complied with.

(e) For defining and allotting the areas of Dominion lands within which the applicant may construct and operate the proposed works; and if there be no Dominion lands available for such purpose then for defining and allotting the lands in regard to which the applicant may exercise the powers given under section 35, subsection 3, of *The Dominion Lands Act.*

(f) For granting a license to the applicant, upon fulfilment of the said agreement, to take, divert and use for power purposes a stated maximum amount of water, in accordance with the application, and plans and specifications as approved by the Minister; the term of such license to be twenty-one years at a fixed fee payable annually, and such license to be renewable as provided for in these regulations.

(g) For granting a lease to the applicant of such Dominion lands as may be allotted under paragraph (e) of this section, and approved of by the Minister, such lease to be at a fixed rental for a term of twenty-one years running concurrently with the said license, and renewable in like manner, and as near as may be subject to all the terms and conditions thereof. When there are no Dominion lands available for such purpose, or when other lands are considered by the Minister to be more suitable for such purpose, then the Minister shall define such lands in regard to which the applicant may exercise the powers given under section 35, subsection 3, of the *Dominion Lands Act.*

7. During the construction of any works for the development of water power the Minister of the Interior, or any engineer appointed by him for that purpose, shall have free access to all parts of such works for the purpose of inspecting same, and ascertaining if the construction thereof is in accordance with the plans and specifications approved of by the Minister, and whether the terms of the agreement, as provided for in the preceding section, are being fulfilled.

Terms of License

8. Upon fulfilment by the applicant of all conditions of the said agreement, the Minister of the Interior shall grant to the applicant a license as agreed upon; and such license shall contain clauses to provide as follows:

(a) The term of the license shall be twenty-one years, renewable for three further consecutive terms of twenty-one years each, at a fixed fee payable annually, and to be readjusted at the beginning of each term, as hereunder provided.

(b) At the expiry of each term of twenty-one years the Governor in Council, may, on the recommendation of the Minister, order and direct that the license and any lease granted in connection therewith be cancelled: Provided that the Minister shall have given at least one year's notice to the licensee of intention so to cancel.

(c) If the licensee shall refuse to pay the license fee as readjusted by the Governor in Council, or as fixed by arbitrators chosen as provided in paragraph (e) hereunder, then in such case the Minister may renew the license at the former fee, or the Governor in Council may, on the recommendation of the Minister, order and direct that the license and any lease issued in connection therewith be cancelled.

(d) In either of the above cases compensation shall be paid to the licensee as provided for in paragraph (e) hereunder.

(e) On termination of the third renewal of such license, except in case of default on the part of the licensee in observance of any of the conditions thereof, or of any lease granted in connection therewith, compensation shall be paid for the works to the amount fixed by arbitration, one arbitrator to be appointed by the Governor in Council, the second by the licensee, and the third by the two so appointed. If the licensee fails to appoint an arbitrator within ten days after being notified by the Minister to make such appointment, or if the two arbitrators appointed by the Governor in Council and the licensee fail to agree upon a third arbitrator within ten days after their appointment or within such further period as may be fixed by the Minister in either such cases such arbitrator or third arbitrator, as the case may be, shall be appointed by the Judge of the Exchequer Court of Canada. In fixing the amount of compensation only the value of the actual and tangible works and of any lands held in fee in connection therewith shall be considered, and not the value of the rights and privileges granted, or the revenues, profits or dividends, being, or likely to be, derived therefrom.

(f) The license shall state the maximum amount of water which the licensee may divert, store and use for power purposes, and shall provide for the return to the stream, or other source of water, of the full amount so diverted.

(g) The licensee shall develop such power as, in the opinion of the Minister, there shall be a public demand for, up to the full extent possible from the amount of water granted by the license.

(h) Upon a report being made by the Minister of the Interior to the Governor in Council that the licensee has not developed the amount of power for which there is a public demand, and which could be developed from the amount of water granted by the license, the Governor in Council may order to be developed and rendered available for public use the additional amount of power for which there is, in the opinion of the Minister, a public demand, up to the full extent possible from the amount of water granted by the license, and within a period to be fixed by the Minister, which period shall not be less than two years after the licensee or person in charge of the existing works shall have been notified of such order, and in default of compliance with such order the Governor in Council may direct that the license, together with any lease issued under these regulations shall be cancelled, and the works shall thereupon vest and become the property of the Crown without any compensation to the licensee.

(i) Upon a report being made by the Minister of the Interior to the Governor in Council that a greater amount of water-power could be developed advantageously to the public interests from the same stream or other source of water from which the existing works derive power, and (1st) that the existing works could be enlarged or added to for such purpose, then the Governor in Council may authorize the Minister to offer the licensee the privilege of constructing and operating such enlarged or additional works at or in the vicinity of the existing works, and to grant such supplementary license as he may consider proper for such purpose, and if the licensee fail within six months thereafter to accept such offer, and in good faith to begin and carry on to completion such enlarged or additional works, and to complete

same in accordance with plans and specifications approved of by the Minister, and within a fixed period not to exceed five years, and upon like conditions as the existing works were begun and completed; or (2nd) if the Minister shall report to the Governor in Council that the existing works, owing to their location or construction, cannot advantageously be enlarged or added to in order to develop further power sufficient to meet the probable demand, or would be a hindrance to other works contemplated for such purpose; or, (3rd) that the existing works cannot, or will not, be any longer advantageously operated owing to the exercise of rights existing or created under The *Irrigation Act;* then in every such case, the Governor in Council may order and direct that the license, and any lease in connection therewith, and all rights thereunder, shall be cancelled, and the existing works shall thereupon vest in and become the property of the Crown; Provided always that in every such case compensation shall be paid to the licensee as provided for in paragragh (e) of section 8 of these regulations, together with a bonus apportioned as follows:

(1) If the works have been in operation less than five years, a thirty per cent. bonus upon the value of the works.

(2) If in operation more than five, and less than ten years, a twenty-five per cent. bonus.

(3) If in operation more than ten, and less than fifteen years, a twenty per cent. bonus.

(4) If in operation more than fifteen, and less than twenty years, a fifteen per cent. bonus.

(5) If in operation twenty years or more, a ten per cent. bonus.

(j) That the license shall not be transferable without the written consent of the Minister, and that if the licensee fail to keep and observe all or any of the conditions of the license, or any renewal thereof, or of any lease to be issued in connection therewith, then the license, together with such lease, shall in every such case be subject to cancellation by the Exchequer Court on the application of the Crown.

(k) That a schedule of rates and prices to be charged to the public for the use of power shall first be submitted by the licensee to the Board of Railway Commissioners of Canada for adjustment and approval before being put into effect, and that no rates or prices for power shall be legal or enforceable until such schedule has been so adjusted and approved nor if they shall exceed the amount fixed by such schedule; and that such schedule shall be readjusted and approved by the Board every seven years during the term of the lease and license, and all renewals thereof.

(l) That for the purpose of ascertaining the quantity of power actually developed, or capable of being developed, from the amount of water granted by such license, the Minister, or any engineer appointed by him for that purpose, shall have free access to all parts of the works, and to all books, plans or records in connection therewith, bearing on the quantity of power developed, and may make measurements, take observations and do such other things as he may consider necessary or expedient for such purpose, and the findings of the Minister, or such engineer, thereon shall be conclusive and binding upon the licensee.

(m) For the proper provision, as required by law, for the passage of logs and timber down the stream or other waterway affected by the works.

(n) For the erection and maintenance by the licensee of a durable and efficient fishway in the stream or other waterway affected by the works when so required by the proper officer or authority in that behalf.

(o) That the licensee shall have no right to any water beyond the amount stated in the license.

(p) For the indemnifying of the Crown against all actions, claims or demands against it by reason of anything done by the licensee in the exercise, or purported exercise, of the rights and privileges granted under the lease or license.

9. The agreements and licenses to be issued hereunder shall, subject always to the provisions of these regulations, be in snch form and contain such provisions as the Minister may from time to time determine.

Storage of Water

10. If at any time it is proposed by the applicant or the licensee to divert water from any lake or body of water for storage purposes, or to dam same in order to augment the flow of water in any stream from which water-power is to be developed, the applicant or licensee shall, in addition to other information required under these regulations, file plans as follows:

(a) A general plan in duplicate, on tracing linen, showing the location of such lake or other body of water, and the lands to be submerged or otherwise affected, and contour lines showing the water level at high and low stages, and the level to which it is proposed to raise such water for storage, and the estimated storage capacity of such lake or other body of water.

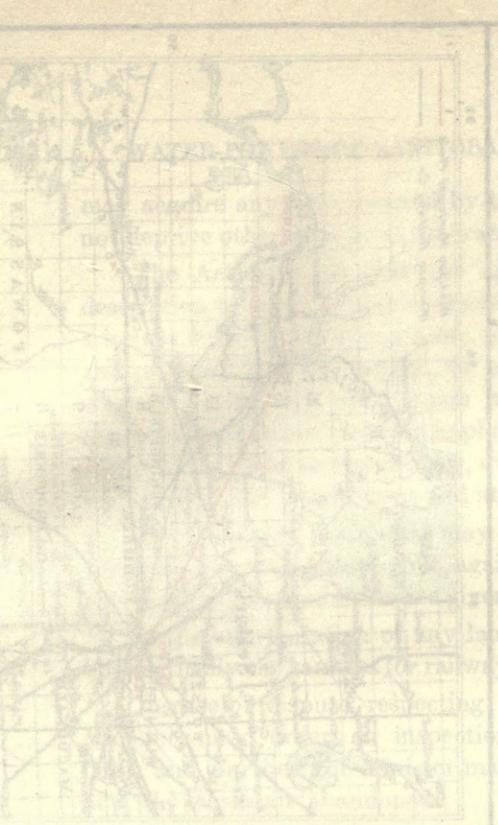
(b) A plan in duplicate, from actual survey, by a Dominion Land Surveyor, and certified to by him, showing the lands to be submerged or otherwise affected by the proposed storage; the name of the registered owner in fee of such lands, and of any registered mortgagee or lessee thereof, and of any claimant in actual possession other than a registered owner, mortgagee or lessee.

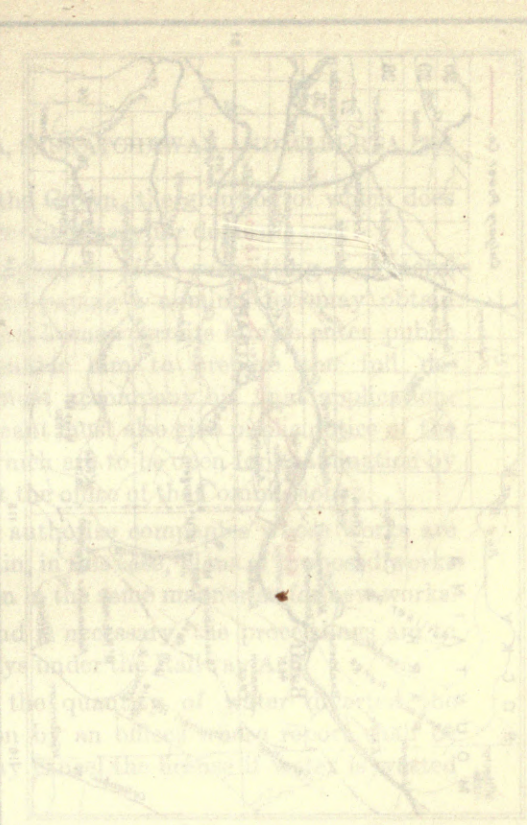
(c) A detail plan in duplicate on tracing linen, showing all dams and other works proposed to be constructed in connection with such storage.

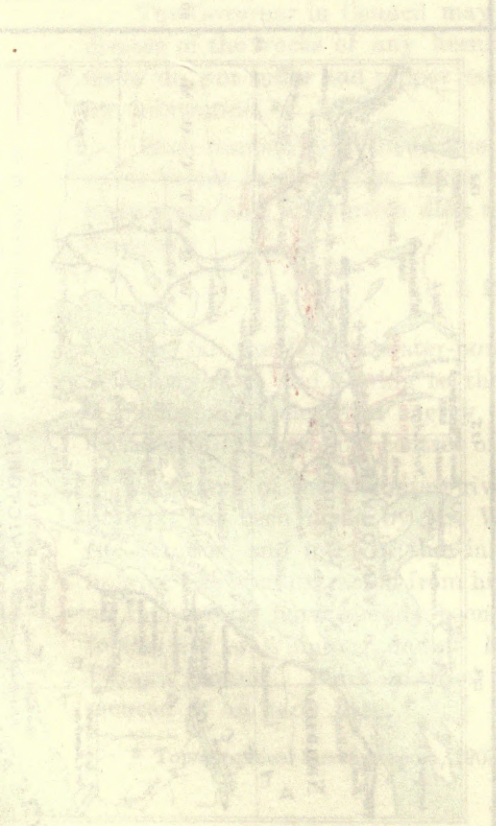
11. When the plans for such storage of water have been approved of by the Minister of the Interior, provision for same shall be made in the agreement for a license, or in the license itself, or in a supplementary license to be issued for such purpose, upon such terms and conditions as may appear to the Minister reasonable or expedient in the circumstances of each case, and subject to these regulations.

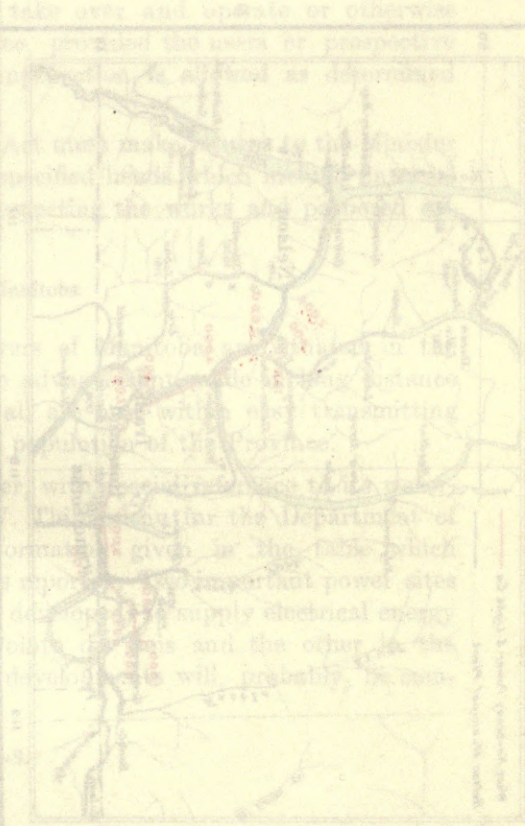
Irrigation Act

This Act applies to the provinces of Saskatchewan, Alberta and to the North West Territories with the exception of the districts of Mackenzie, Franklin, and Ungava; its application being governed by the Minister of the Interior. Companies formed to promote irrigation are subject to its provisions and upon proper application

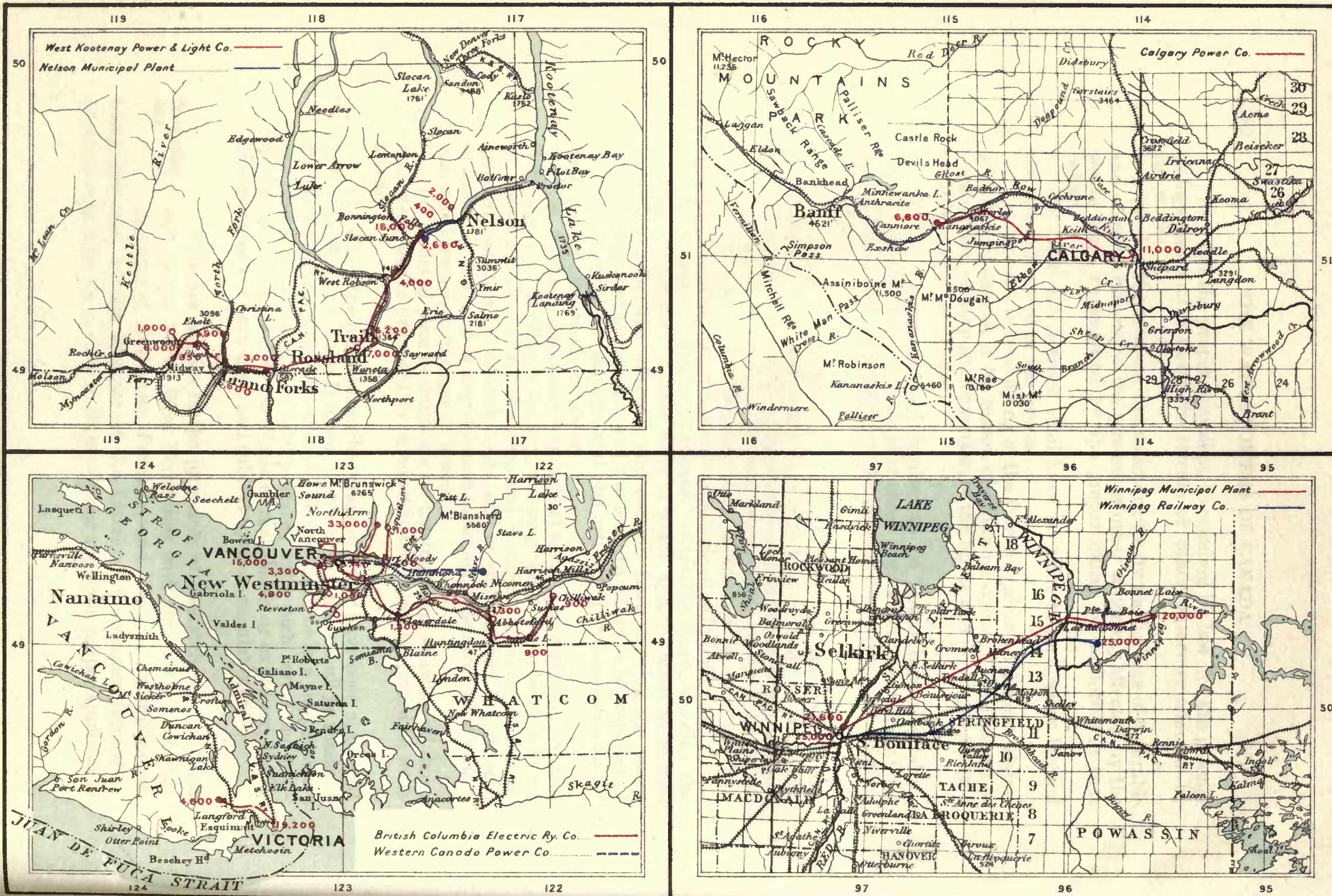








TRANSMISSION LINES IN WESTERN CANADA



may acquire any water owned by the Crown, the granting of which does not deprive other persons of the water necessary for domestic use.

The Act provides that the applicant, after submitting a general description of his proposed works and paying a nominal fee, may obtain a license from the chief engineer; this license permits him to enter public and private lands for survey to enable him to prepare the full description and detail plans which must accompany his final application. Once the application is in, the applicant must also give public notice of the fyling of the plans and memorials, which are to be open for examination by the public in the Department and at the office of the Commissioner.

The Governor in Council may authorize companies whose works are contiguous to amalgamate; but, again, in this case, plans of proposed works must be fyled and public notice given in the same manner as for new works.

If the expropriation of any land is necessary, the proceedings are to be practically the same as for railways under the Railway Act.

In case of dispute respecting the quantity of water diverted, the Minister may order an inspection by an officer whose report shall be final; and, further, the Minister may cancel the license if water is wasted or if the works are abandoned.

The Governor in Council may take over and operate or otherwise dispose of the works of any licensee, provided the users or prospective users do not suffer and proper compensation is allowed as determined by arbitration.

Each company subject to this Act must make returns to the Minister on or before January 31st, under specified heads which include financial statements and descriptive data respecting the works and proposed extensions.

I. Manitoba

By far the largest water-powers of Manitoba are situated in the Winnipeg river and, owing to the advancement made in long distance transmission of electrical energy, all are now within easy transmitting distance of the principal centres of population of the Province.

A survey of the Winnipeg river, with special reference to its water-powers, has been made by Mr. W. Thibaudeau for the Department of the Interior, and most of the information given in the table which follows, has been extracted from his report.* Two important power sites on this stream have already been developed, to supply electrical energy to the city of Winnipeg, one at Pointe du Bois and the other in the Pinawa channel. Work on other developments will, probably, be commenced at an early date.

* Topographical Survey report, 1907-8.

There are also water-powers in the western portion of the Province in the Little Saskatchewan, Assiniboine, and other rivers; but these, although of some importance on account of their geographical positions, are smaller than those of the Winnipeg river.

Notes on Some of the Power Sites

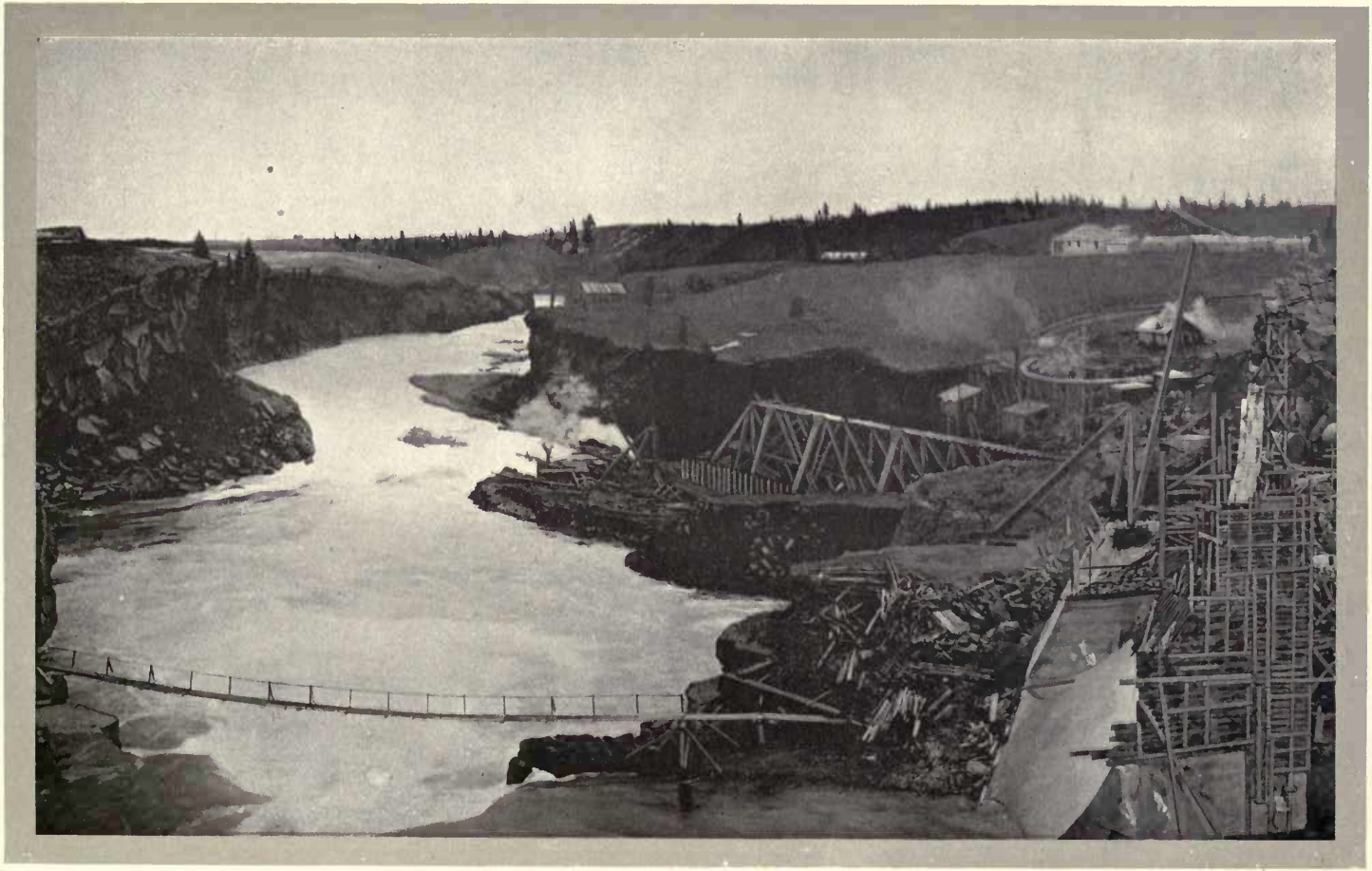
WINNIPEG RIVER.*—The Winnipeg river has its source in the lake of the Woods, which lies, partly, in Manitoba, partly, in Ontario, and partly, in Minnesota. The lake has an area of over 1,850 sq. miles and is controlled at Kenora by a dam. The Winnipeg river with its tributary, the English, has a drainage basin of some 44,000 sq. miles. Of its length of 158 miles, 105 miles are in Manitoba and 53 miles in Ontario. Of this basin, the English river drains 20,600 sq. miles. Practically the whole of this drainage basin is underlain by Archæan rocks. It has a considerable portion of forested area untouched by the lumberman, and a multitude of lakes of various sizes whose total area aggregates 5,650 sq. miles. The largest of these is the lake of the Woods.

Various discharges are given for the Winnipeg river, and, from these, minimum flows have been estimated by several engineers. The lowest estimate is 16,000 cubic feet per second, and and has been adopted in the accompanying table.

The numerous lakes, swamps, and muskegs of this region have, naturally, tended to make the discharge of the river more uniform. The forest denudation which has taken place through lumbering operations, through fires, and through settlement, sparse though it is, has doubtless increased the range of variation in discharge, but, on the other hand, the improvements at the outlets of the lake of the Woods have had the contrary effect. This lake has an estimated storage capacity of seventy per cent. of the yearly run-off and could be so controlled as to almost double the present minimum flow of the Winnipeg river, but, as a portion of it is in the United States raising the level would involve an international question.

The first important fall in ascending the river, is Pine fall, situated on Sec. 29, Tp. 18, R. X. A dam resting on solid granite and about 860 feet long would raise the head to 11.87 feet. Silver and Whitemud falls could be combined by a dam 21 feet high and about 800 feet long, which would give a total head of 43.62 feet. Grand du Bonnet fall is situated on Secs. 14, 15, 22 and 23, Tp. 17, R. XI. Here, a dam could be built to raise the water 14 feet, obliterating McArthur fall and giving a total head of 48.09 feet and a minimum horse-power of 87,250. The total length of the dam across the two channels of the river would be

* Most of the information given here respecting this river was secured from W. Thibaudeau's report already referred to, and from a paper read before the Canadian Society of Civil Engineers, Jan., 1911, by W. G. Chace, who had charge of the construction of the Winnipeg municipal plant at Pointe du Bois.



HORSESHOE FALLS, NEAR KANANASKIS, ALBERTA

about 795 feet, and it would rest on solid granite. The Pinawa channel is used by the Winnipeg Street Railway Co., for their 25,000 H.P. plant. They have had to cut away a large amount of rock from the head of this channel for a distance of four miles. Their diversion weir, which is built across the main channel, raises the water about six feet and has the effect of diverting from the main stream to the Pinawa channel the additional water required at their generating station. At Slave fall, a dam could be built to raise the water 8.19 feet, obliterating the Eight-foot fall and giving a total head of 25.58 feet with a minimum of 46,450 horse-power. This dam would be some 350 feet long, and would rest on solid granite.

Pointe du Bois and Lamprey falls are to be utilized by the city of Winnipeg municipal generating plant. They have been combined by a dam and system of works at the head of Pointe du Bois fall, giving a total head of 45.8 feet. Improvements are being carried out by the city which will improve the regulation of head at this site, so that a maximum variation of not over three per cent. each way from a standard of 45 feet will occur. There was, originally, a stillwater expanse, eight miles long and about 3,600 acres in extent above Pointe du Bois and below Lamprey falls. By the new construction, this acreage has been increased to nearly 6,000, with very considerable advantage to the operation of the city's power plant, since, by using this as a reservoir to take care of the daily variations in load, it is estimated that a peak load of almost double the minimum 24-hour capacity of the river can be carried without objectionable variations of head.

II. Saskatchewan and Alberta

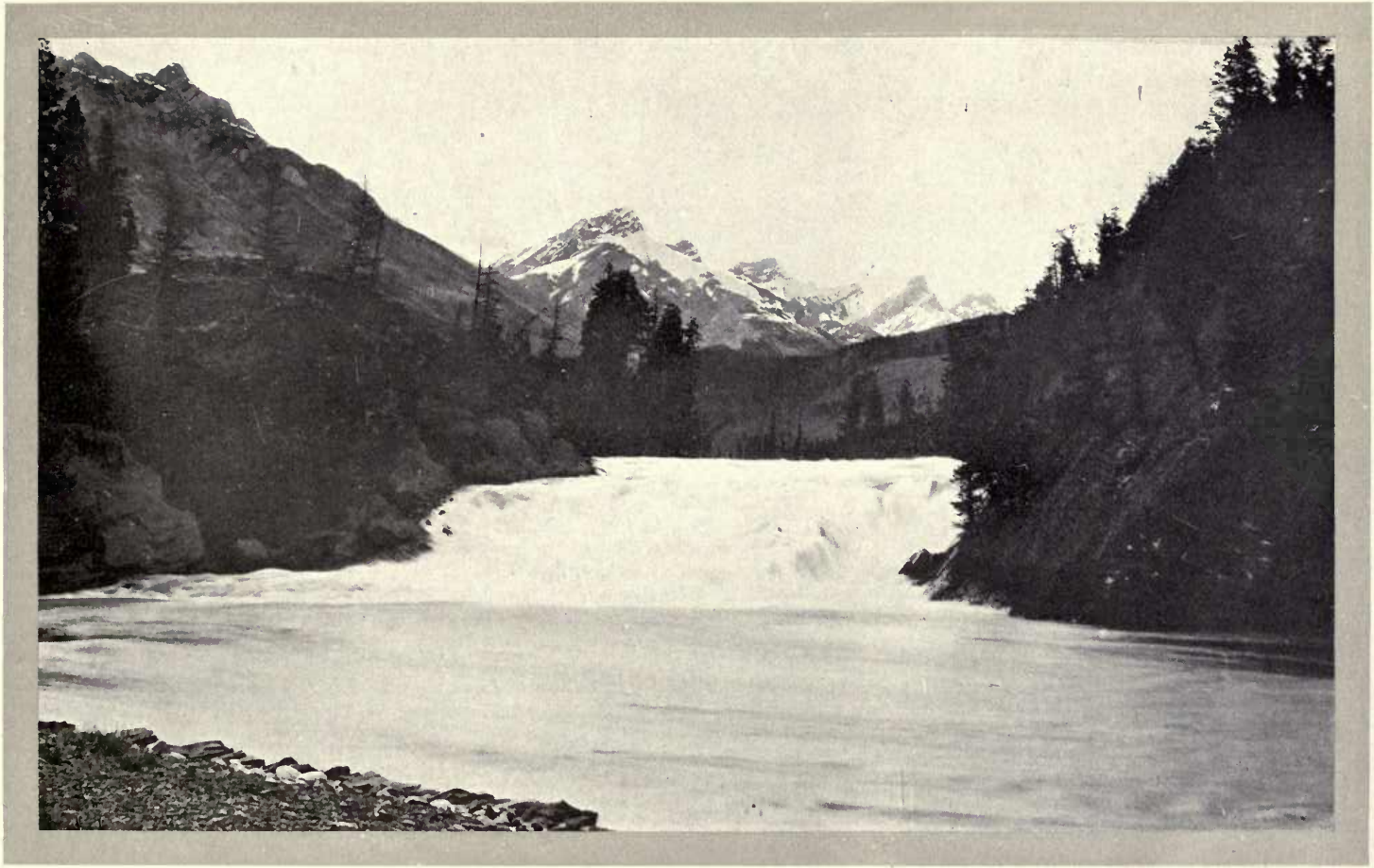
In connection with irrigation, much data have been collected and many observations have been made for the Department of the Interior on streams in the southern portions of these provinces. The Irrigation Survey reports contain valuable data on the flow of streams at different stages. This information can be used in connection with water-power estimates where the available head at the different rapids and falls on the streams is obtainable from other sources or from actual observations. In 1908, stream measurement investigations became a distinct feature of the work and a report by P. M. Sauder on "Progress of Stream Measurements" was published in 1910, giving the results of observations taken on different streams during the years 1908 and 1909.

An investigation of the water-powers of south-western Alberta was made by Mr. W. Thibaudeau for the Topographical Surveys Branch and the report published on this in 1910, gives very complete and comprehensive information on the water-powers in that territory. Some of the water-powers of these provinces have also been investigated by private corporations.

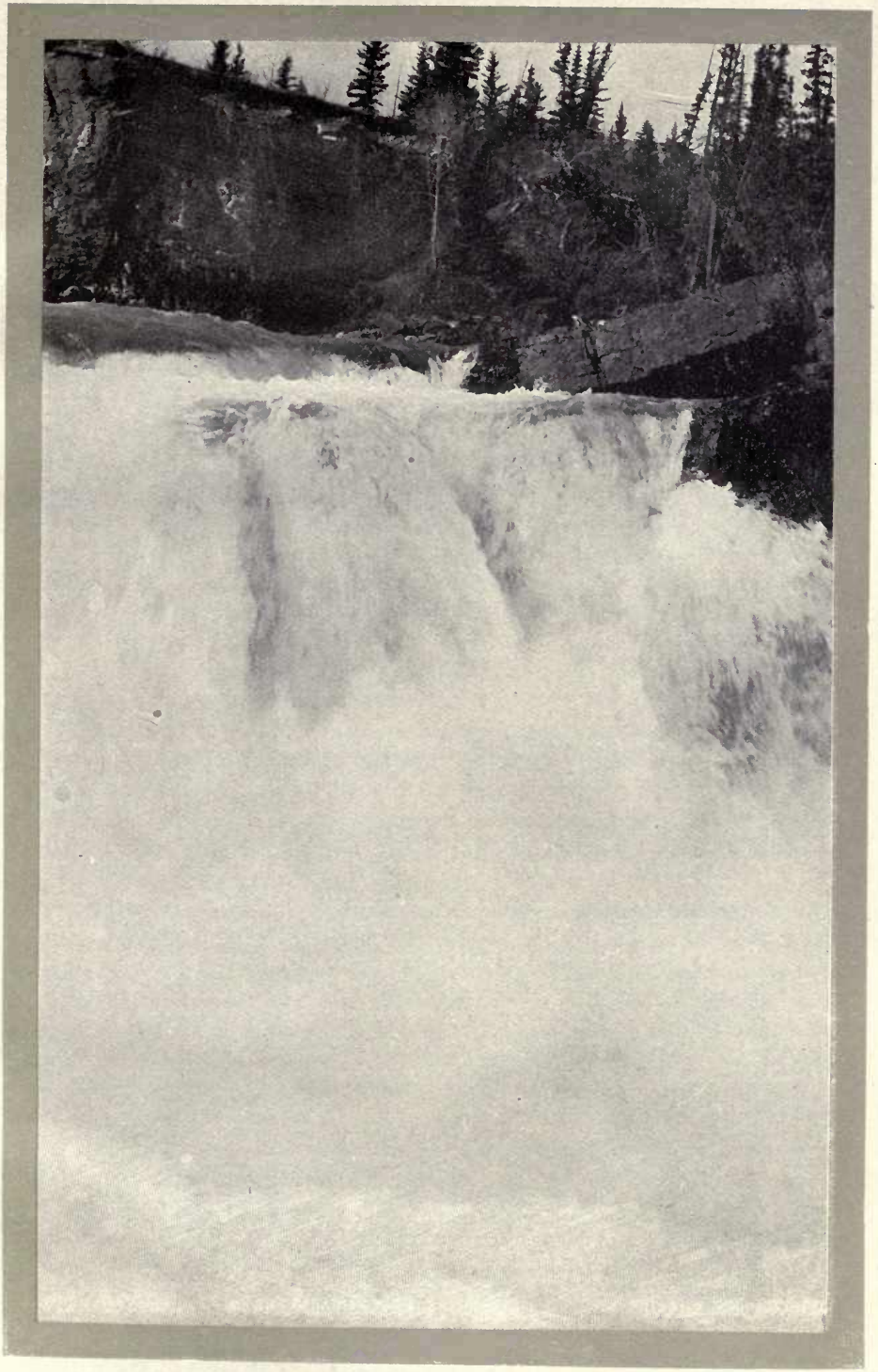
Notes on More Important Streams and Power Developments

NORTH SASKATCHEWAN RIVER.—Notwithstanding the various rapids, the North Saskatchewan river may be considered a navigable stream throughout its length from the head of the Grand rapids, near lake Winnipeg, to Edmonton and beyond. For many years, it has been navigated by the Hudson's Bay Company's steamboats, which make one or two trips a year to carry supplies for the posts. Between Prince Albert and the Grand rapids, a distance of 525 miles along the river, there are only two points where difficulty is experienced in navigating the river on account of rapids. Difficulties are encountered at Cole rapids, which consists of a series of short rapids, and at Tobin rapids, 140 miles below Prince Albert, where there is a series of rapids eight miles in length. Navigation usually begins about the end of May and continues till the low-water season in August. The boats used have a maximum draft of three feet. The proposed development at Cole rapids has for its principal object the supply of electrical energy to Prince Albert, 25 miles distant. It includes the building of a heavy dam and lock to provide for the navigation of the river. The minimum discharge of the river at this point is taken to be 4,600 cubic feet per second, and, under the head of 28 feet which can be obtained, would give 14,700 theoretical horse-power.

BOW RIVER.—The Bow river rises in the watershed of the Rocky mountains, and flows in a southeasterly direction until it reaches the foothill country at the "Gap." It then turns to the east as far as Calgary, and, thence, runs south and east to its confluence with the Belly river. Between its source and the "Gap," a number of streams flow into it from the various mountain valleys that it intersects. Almost immediately after leaving the mountains it is joined from the south by the Kananaskis river, a stream of good size and fairly uniform flow, which has its source in the eastern ranges of the Rocky mountains in muskegs and lakes lying at a considerable elevation. From this point to its confluence with the Belly river, the Bow furnishes the run-off channel for the eastern slope of the Rocky mountains and is fed by numerous streams. It flows in a deep valley, some hundreds of feet below the surrounding bench land, in a well-defined channel, with banks and bottom of coarse gravel, large stones and boulders. It is broken in several places by falls and rapids. At Calgary, a hydro-electric plant, operating under a low head of 14 feet, derives its power from one of these. A large development at Horseshoe and Kananaskis falls, where a head of 70 feet is obtained, is now completed and will supply electrical energy to the city of Calgary and to other interests. The initial installation comprises two generators each of 2,500 K. W. capacity, but the development is designed for an ultimate capacity of some 15,000 H.P. There is another fall of some importance near Banff, a head of about 64 feet being available. As this is much nearer the head-waters, less power than that which can be obtained at the sites previously referred to, is available.



Bow River Falls, Rocky Mountains Park, Banff, Alberta



KANANASKIS FALLS, KANANASKIS, ALBERTA

The Bow river is tapped at Calgary to supply the Canadian Pacific Railway Company's irrigation canal, which, at times, takes over 450 c. f. s. or more than one-third of the low-water flow of the river at this point.

St. Mary River.—The upper St. Mary river valley which is well defined, and consists of rolling slopes and "cut banks," is half a mile wide. Through it the river flows at an average depth of 140 feet below the surface of the surrounding country. From Secs. 23 to 25, Tp. 1, R XXX, the valley takes the form of a cañon which averages 150 feet in depth. The bottom is of solid sandstone and limestone, visible nearly everywhere. The upper portion of the river valley to the international boundary consists, alternately, of flats and cut banks, 50 to 100 feet high. The drainage conditions are favourable for a quick run-off. Power could be developed at Sec. 25, Tp. 1, R. XXV, by building a dam, but a higher head could be obtained by carrying the water from the international boundary by a canal and pipes to the point above mentioned, a total distance of about ten miles. The lower portion of the St. Mary river can hardly be depended upon for water-power, at least during the season of irrigation, as the Alberta Railway and Irrigation Company have secured the right to use practically the whole flow of the river for irrigation purposes.

Other streams in southwestern Alberta, in which water-power varying from 600 to 2,700 H.P., could be developed, are Tib creek, Blakiston brook and Waterton, South Fork, Oldman, Crownest, Livingstone, Sheep and Elbow rivers. All the streams in the Rocky mountains, the Red Deer, Clearwater, North Saskatchewan and its mountain tributaries, the Athabaska, Smoky, Wapiti, Peace and many other rivers will permit large developments and, in most instances, are fed by glacier streams with a summer flow that is rendered fairly uniform by the discharge from the melting *mers de glace.*

Athabaska River.—Rising in the watershed range of the Rocky mountains and receiving many glacial tributaries, the Athabaska contains many valuable power sites between its source, at an altitude of about 5,000 feet, and its *débouchement* into lake Athabaska at an altitude of 690 feet. Of these, the most noted are at the succession of falls and rapids known collectively, as the Grand rapids. As they can only be rendered navigable by canals, the question of interference with navigation does not require consideration.

Peace River.—The remarks respecting the Athabaska also apply in large measure to this river. In addition to the power sites in the ranges west of the Rockies, there are two important sites on this stream. The upper is at Rocky Mountain portage. At this point the river is a raging torrent flowing 25 miles through a cañon, and has a total fall of 270 feet. The lower is situated at Vermilion fall, the only interruption to navigation between its confluence with Slave river and above Dunvegan, a distance of upwards of 530 miles.

III. Yukon

There is very little information available respecting the water-powers of Yukon territory, though it contains many magnificent powers, only one of which has been developed. This power has been developed by the Yukon Gold Company, on Little Twelve-mile creek, near Dawson, It operates all their dredges and hydraulic lifts and their machine shops. The dredges are among the largest of their kind in the world. This power-plant receives 60 cu. ft. of water per second under an effective head of 650 feet. It has a capacity of 2,000 H.P., which is transmitted, at a tension of 33,000 volts, 36 miles straight across country.

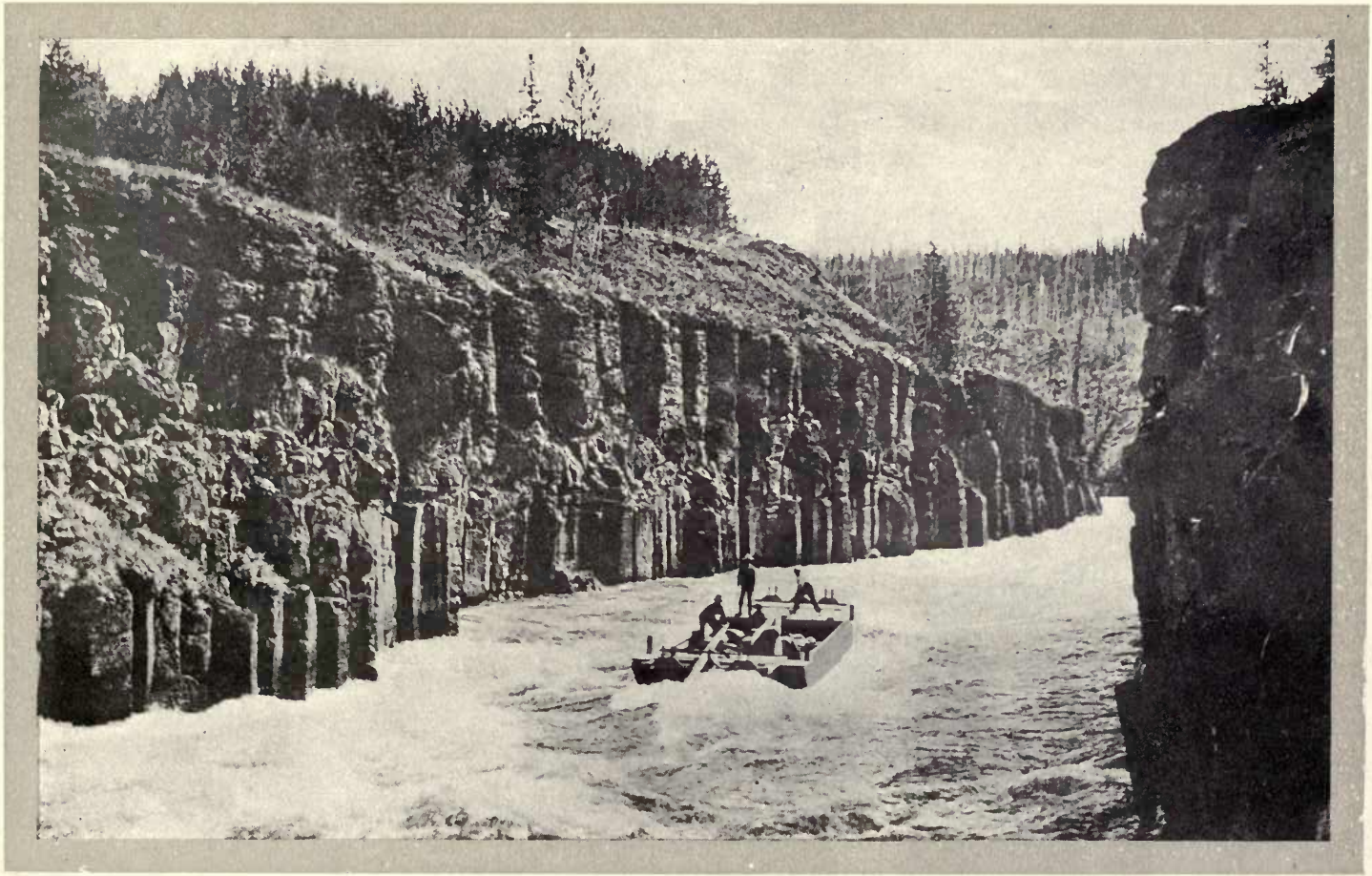
The table below gives the discharge of some of the principal rivers of Yukon and of the Mackenzie.

River	Discharge	Remarks
Yukon river:		
At Fort Selkirk	66,955	Flood discharge, 167,400
Lewes river, at Fort Selkirk	37,672	
" " above mouth of Teslin	18,664	Low water discharge, 15,600
" " above mouth of Takhini, about	7,200	Fall in Miles cañon and White-horse rapid about 35 ft.
Teslin river, at mouth	11,436	
Big Salmon river, at mouth	2,726	
Takhini river	3,600	
Pelly river, at Fort Selkirk	29,283	
" " at Pelly Banks	4,898	Fall in Hoole cañon, 20 ft; rapid 17 miles east of Hoole cañon, fall 8 ft.
Macmillan river, at mouth	9,796*	
Ross river, at mouth	4,898*	
Liard river:		
†Upper Liard river, at junction with Dease river, estimated	19,000	Approximate mean stage
Frances river, at Upper cañon	.....	Fall, about 30 ft.
*†Mackenzie river, about	500,000	Approximate mean stage

* The discharge of the Ross is taken as equal to that of the Pelly at "Pelly Banks;" that of the Macmillan is as equal to the combined waters of the Pelly and Ross.

† In British Columbia, near southern boundary of Yukon.

*† In North West Territories.



WHITE HORSE RAPIDS, LEWES RIVER, YUKON

HYDRAUL'ICING IN AMERICAN GULCH, YUKON

NORTH WEST TERRITORIES

WATER-POWERS*

Power Site	Approximate Head, in feet	Estimated Horse-power	Remarks
Nelson river: †			
903. Limestone rapid	85*†	1,140,000	
904. Long Spruce "	85	1,140,000	
905. Kettle "	96	1,290,000	
906. Gull "	67	900,000	
907. Birthday "	24	320,000	
908. Grand "	20	270,000	
909. Rapids above Sepewesk lake.	31	416,000	
910. Bladder rapid	10·6	147,000	
911. Whitemud fall.....	30	403,000	
912. Ebb-and-Flow rapid.....	11	148,000	
913. Rapids above Cross lake....	45	605,000	
Saskatchewan river:			
914. Grand rapids ‡.....	100	80,000	

Stream Flow

The following table gives information respecting the flow of some of the streams in Saskatchewan and Alberta.** It was obtained at points where regular observations were taken as described in the first part of this section. No observations were taken during the winter months (December, January, February, March nor, in most cases, November).

SASKATCHEWAN

MEASUREMENTS OF STREAM FLOW

Observation Point	Yearly maximum (in c. f. s.)	Yearly minimum (in c. f. s.)	Drainage area in sq. miles	Remarks
Maple creek				
Near Maple Creek.....	.....	0·04	91	Gaugings in 1909 only
Piapot creek				
Sec. 17, Tp. 11, R. XXIV.....	552	1·35	50	Gaugings in 1909 only
Bear creek				
Sec. 18, Tp. 11, R. XXIII.....	741	1·8	95	
Frenchman river				
Sec. 31, Tp. 6, R. XXI.	1,534	16·4	635	Gaugings in 1909 only
Fairwell creek				
Sec. 30, Tp. 6, R. XXIV.....	471	3·25	135	Gaugings in 1909 only

* No reliable data are available respecting the numerous other powers in the rivers of the North West Territories and they have, therefore, been omitted pending the collection of reliable information respecting them.

† Drainage area of Nelson river = 430,000 square miles; the estimated H. P. is based on a flow of 118,400 c. f. s. obtained from a gauging taken just below Sepewesk lake when the river was stated to be at a very low stage.

*† In many cases it would be difficult to utilize the full head.

‡ The estimated H.P. is based on the combined minimum flow of the North Saskatchewan at Prince Albert and of the South Saskatchewan at Saskatoon (7,100 c. f. s.)

** From observations taken in 1908 and 1909 for the Department of the Interior.

ALBERTA

MEASUREMENT OF STREAM FLOW

Observation Point	Yearly maximum (in c. f. s.)	Yearly minimum (in c. f. s.)	Drainage area in (sq. miles)	Remarks
Bow river				
Calgary, below Elbow river and Can. Pac. canal	22,051	1,280	3,828	Water in Can. Pac. canal has been added to discharges taken below its intake
Can. Pac. canal	468	.....	.....	No water withdrawn except during season of irrigation
Banff	11,060	375	876	Gaugings in 1909 only
Highwood river				
High river	9,180	115	735	
Sheep river				
Okotoks	7,685	72	602	
Fish creek				
Near Priddis	556	5	105	
Elbow river				
Calgary	5,615	212	466	
Jumpingpound creek				
Near Jumpingpound P. O.	829	20	178	
Belly river				
Standoff	3,330	132	423	Gaugings in 1909 only
Mosquito creek				
Near Nanton	931	5	178	
St. Mary river				
Kimball	7,280	290	472	Gaugings in 1909 only
Lee creek				
Cardston	.....	7	103	Gaugings in 1909 only
Oldman river				
Cowley	8,285	170	798	
Trout creek				
Sec. 1, Tp. 12, R. XXVIII	437	15	168	Gaugings in 1909 only
Waterton river				
Waterton mills	7,750	200	238	

MANITOBA

LIST OF WATER-POWERS*

Power Site	Minimum		Developed (Horse-power)			REMARKS
	Head (in feet)	H.P.	Electrical Energy	Flour-mill	Total	
Winnipeg river:†						
852. Pine fall and rapids above	11·8	21,500	.....	.....	.....	
853. Silver fall	22·7	41,100	.....	.....	.....	
854. Whitemud fall and falls above	21·	38,200	.....	.....	.....	
855. Grand du Bonnet fall	34·1	61,800	.....	.....	.....	
856. McArthur fall and falls above	13·8	25,000	.....	.....	.....	
857. Pinawa channel (Winnipeg street Ry. dam)	33·6	25,200	25,000	.....	25,000	Winnipeg Electric Ry. plant
858. Seven rapids — Main channel	17·6	18,700	.....	.....	.....	
	6·5	6,900	.....	.....	.....	
	23·1	24,700	.....	.....	.....	
859. Otter fall and diversion weir	7·2	7,700	.....	.....	.....	
860. Sturgeon fall	4·3	7,800	.....	.....	.....	
861. Slave fall	17·4	31,600				
862. Eight-foot fall	8·3	15,000	.....	.....	.....	
863. Pointe du Bois and Lamprey falls	45·8	83,300	21,600	.....	21,600	Winnipeg municipal electric plant
Assiniboine river:						
864. Eight miles east of Brandon	.....	2,000	.....	.....	.....	Proposed development by the Western Power & Light Co.
865. Near Brandon	9	1,000	.....	.....	.....	Proposed development by city of Brandon
Little Saskatchewan river:						
866. Near mouth	32	300	1,200	.....	1,200	Brandon Electric Light Co. have steam auxiliary.
867. Half-mile above Minnedosa	24	.....	450	.....	450	Minnedosa Power Co.; under construction
Birdtail creek:						
868. Birtle	.....	200	.....	.....	.....	Undeveloped
Shell river:						
869. Asessippi	12	.....	.....	50	50	Flour mill

* This is not presented as even approaching a complete list of powers within the province but, rather, as showing the paucity of available information, and is published in its present incomplete form, pending the collection of additional information.

† The horse-power of the Winnipeg river powers is based on a minimum flow of 16,000 cubic feet per second. Paper by W. G. Chace, Can. Soc. C.E. meeting, Winnipeg, January, 1911. According to W. Thibaudeau, the minimum flow is 19,400 cubic feet per second.

SASKATCHEWAN

LIST OF WATER-POWERS*

Power Site	Minimum		Developed Horse-power			REMARKS
	Head (in feet)	H.P.	Electrical Energy	Saw-mill	Total	
Black river:						
870. Below Middle lake	160	.....	.....	.....	.....	
871. Above " "	120	.....	.....	.....	.....	
872. 8 miles below Porcupine river	25	.....	.....	.....	.....	
873. Brink rapid, 10 miles above Hawk-rock river	25	.....	.....	.....	.....	
874. Thompson rapid, 8 miles below Kosdaw lake	30	.....	.....	.....	.....	
Barrier river:						
875. 18 miles south of Star City	8	.....	.....	45	45	Lumber mill; has steam auxiliary
North Saskatchewan river;						
876. Cole rapid	28	14,700	.....	.....	.....	Proposed development for Prince Albert
Battle river;						
877. 10 miles above Battleford	65	2,000	.....	.....	.....	Proposed development for Battleford; head to be created by dam
South Saskatchewan river;						
878. 15 miles below Saskatoon	15	3,500	.....	.....	.....	Proposed electrical development

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ALBERTA

LIST OF WATER-POWERS*

Power Site	Minimum		Developed (Horse-power)			Remarks
	Head (in feet)	H.P.	Electrical energy	Sawmill	Total	
Peace river:						
879. Vermilion fall and rapids	20	.....	.....	.....	.....	Grist mill; at low water, 15 to 20 feet; at high water they become greatly reduced and have been run by a York boat
†Athabaska river;						
879a. Cascade rapid	7	.....	.....	.....	.....	
879a. Little Cascade rapid	10	.....	.....	.....	.....	
879a. Rock "	12	.....	.....	.....	.....	
879a. Crooked "	13	.....	.....	.....	.....	
879a. Long "	28	.....	.....	.....	.....	Three miles long
879a. Middle "	25	.....	.....	.....	.....	
879a. Boiler "	25	.....	.....	.....	.....	
879a. Brulé "	8	.....	.....	.....	.....	
*†880. Grand rapids	55	.....	.....	.....	.....	
881. Joli Fou "	.....	.....	.....	.....	.....	
882. Stony "	.....	.....	.....	.....	.....	
883. Pelican "	12	.....	.....	.....	.....	
884. 160 miles west of Athabaska Landing	80**	.....	.....	.....	.....	Falls extend over one mile
North Saskatchewan river:						
885. Rocky rapids, 60 miles above Edmonton	.....	35,000**	.....	.....	.....	Proposed development of a minimum capacity of 10,000 H.P.
Sturgeon river:						
886. Near Fort Saskatchewan	.....	.....	.....	.....	.....	Hydro-electric plant; under consideration

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† The rapids of the Athabaska begin below the Pelican river and continue at short intervals all the way to the junction of the Clearwater; average fall per mile, 5 to 10 feet.

*† The Grand rapids, in about half-a-mile, descend 50 to 60 feet; fall between the head of the Grand rapids and mouth of the Clearwater, 360 feet.

** Approximate figures only.

ALBERTA

LIST OF WATER-POWERS*—*Continued*

Power Site	Minimum		Developed (Horse-Power)			REMARKS
	Head (in feet)	H.P.	Electrical energy	Sawmill	Total	
Red Deer river:						
887. 3 miles from Blackfalds	.....	3,000†	.....	.....	.....	Undeveloped
Blindman river:						
888. At junction with Red Deer river	30	.....	200	.....	200	Lacombe electric plant; has steam auxiliary
Bow river:						
889. Calgary	14	.....	500	.....	500	Calgary Water Power Co.; has steam auxiliary
890. Horseshoe and Kananaskis falls	70	6,200	6,600	.....	6,600	Calgary Power Co. development
891. Banff falls	64	3,000	.....	.....	.....	
Belly river:						
892. Sec. 33, tp. 8, range 24	.....	1,200	.....	.....	.....	
St. Mary river:						
893. Sec. 24, tp. 6, range 23	90	.....	.....	.....	.....	Almost entire flow of river has been secured for irrigation during irrigation season
894. Sec. 25, tp. 1, range 25	238	14,933	.....	.....	.....	For mean flow of river; intake 10 miles distant
Lee creek:						
895. Cardston	127	172	.....	.....	.....	Intake 4 miles distant
Tib creek:						
896. Tp. 1, range 28	349	1,364	.....	.....	.....	Intake 4 miles distant
Blakiston brook:						
897. Sec. 6, tp. 2, range 29	158	712	.....	.....	.....	Intake 5 miles distant
Waterton lake:						
898. Sec. 24, tp. 1, range 30	50	1,127	.....	.....	.....	
Oil creek:						
899. Sec. 23, tp. 1, range 30	250	392	.....	.....	.....	Intake half-mile distant
South Fork river:						
900. Sec. 24, tp. 6, range 2	120	2,700	.....	.....	.....	
Crownest river:						
901. Sec. 28, tp. 7, range 2	40	630	.....	.....	.....	
Gold creek:						
902. North of Frank	100	.....	.....	.....	.....	Undeveloped

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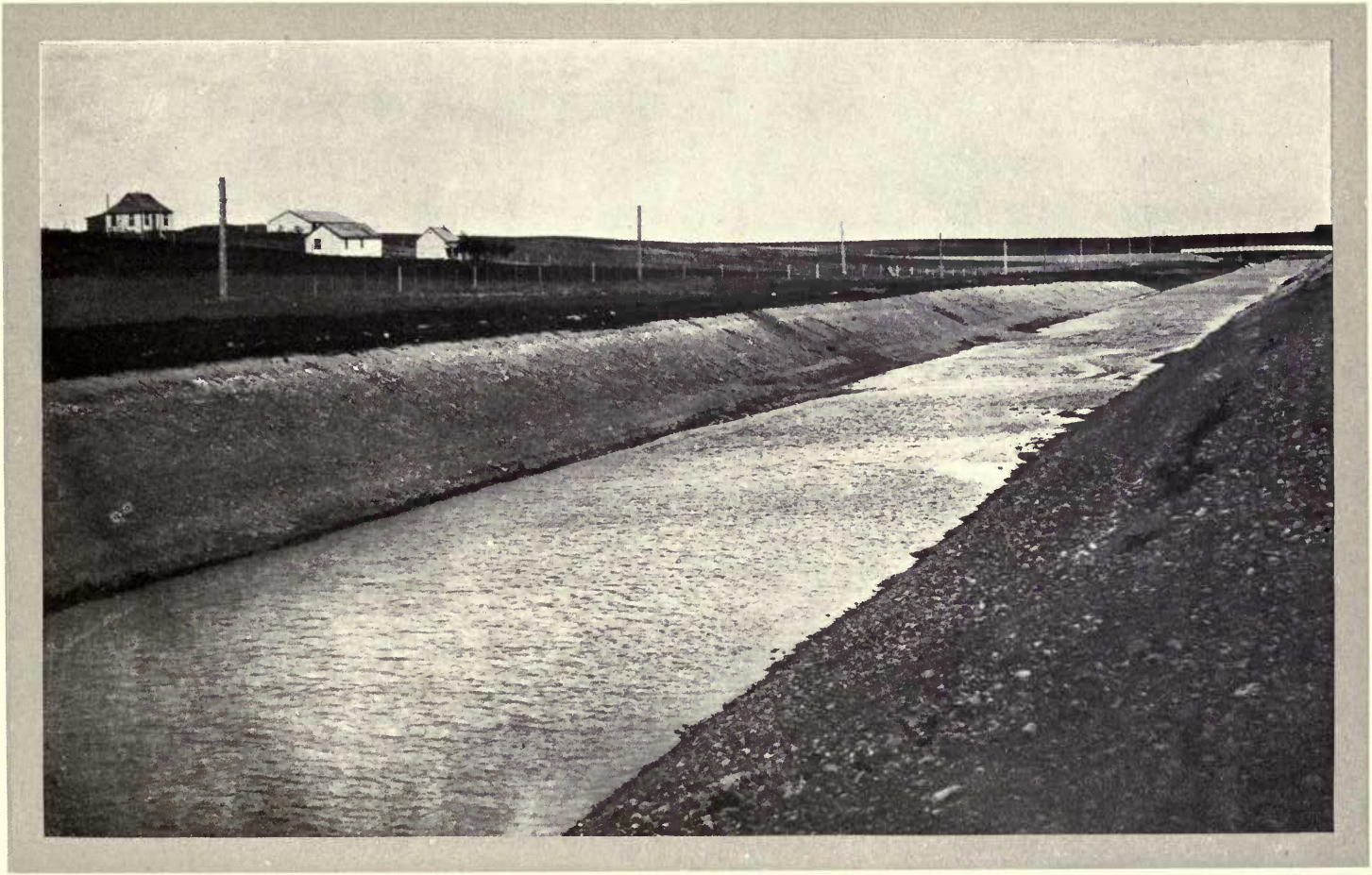
† Approximate figures only.



MAIN CANAL, CANADIAN PACIFIC RY. IRRIGATION BLOCK, ALBERTA

CHAPTER IX

Irrigation in Western Canada*

IRRIGATION, or the artificial watering of land, is not by any means a modern achievement. Remains of elaborate systems constructed and used by the ancients, may be seen to-day in Mexico, Southern Europe, Egypt and in parts of Asia. It is, however, only within comparatively recent times that irrigation has been used in reclaiming many areas lying west of the Mississippi, and in Western Canada, that had hitherto been almost waste land.

Portions of the provinces of Saskatchewan, Alberta and British Columbia, usually have a very erratic rainfall. In some instances, as in the case of the Thompson River valley in British Columbia, the rainfall is usually sufficient, but it is unevenly distributed, while in the Okanagan and Columbia valleys it is never large, and irrigation is a necessity.

Water rights for irrigation purposes in British Columbia have heretofore been obtained under the old placer mining laws and have, in several cases, resulted in a clash between the two interests. To obviate that, the Provincial Legislature has formed a commission to adjust the matter of water rights and provide, if possible, a uniform system of dealing with the water for both irrigation and mining purposes. Until some such arrangement is arrived at, the irrigation interests will be in more or less trouble with the prior rights to the water for mining purposes, even though those rights may not have been exercised in a long period of years.

In Southern Alberta, too, the rainfall varies greatly from year to year, and the distribution is a very uncertain quantity. There are very few years, however, that a crop would be a total failure, but, in the most favourable seasons, an application of water at the right time would increase the harvest to such an extent that the construction of an expensive irrigation system would be justifiable.

There are several such systems in existence, notably that of the Alberta Railway and Irrigation Company at Lethbridge, the Southern Alberta Land Co. at Medicine Hat, and that of the Canadian Pacific railway at Calgary.

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*This chapter was kindly contributed by Mr. George B. Hull, C.E., except the information respecting the Eastern and Middle Sections of the Canadian Pacific Irrigation Block which was contributed by Mr. A. S. Dawson, C.E., Chief Engineer, Irrigation Department, Canadian Pacific Railway Co.

Alberta Railway and Irrigation Co.

The Alberta Railway and Irrigation Co. at Lethbridge, by constructing lines of railway from Lethbridge to Dunmore Junction, Alta., and to Great Falls, Montana, earned a land subsidy of approximately 1,000,000 acres, which they selected along the line of their track east and south of Lethbridge. As these holdings were in alternate sections, arrangements were, later, made with the government whereby the company was able to select its land in a solid block. With this done, the company constructed a canal leading out of the St. Mary river about three miles north of the international boundary, thence across the divide which separates the river from a creek known as Spring Coulee, and out of this again into Pothole creek, from which stream it was taken out onto the Lethbridge plains.

This canal made available for settlement a large area of hitherto worthless land whose development, subsequent to the construction of the canal, has been very rapid. Where in 1899 and 1900, one could not see a fence or building there are now prosperous farms. Three new towns, Sterling, Raymond and Magrath sprang into existence in a few months after the land was placed on the market. At Raymond, is a half-million dollar beet sugar refinery, which is kept busy making sugar from beets grown on what was considered a few years ago, as worthless land and over which roamed the cattle of the ranchers.

Southern Alberta Land Co.

The Southern Alberta Land Co., Medicine Hat, obtained by purchase and from the Dominion Government under the North West Irrigation Act, approximately half a million acres of raw prairie land and are, at present, building an irrigation system to serve it. This land lies between the Bow and Belly rivers and, when the system is finally completed, it will probably irrigate about 300,000 acres.

The construction of the main canal presented some engineering difficulties that almost prevented the building of the system. The water, owing to the nature of the country, had to be taken from the Bow river. The elevation of the land was so much higher than the bed of the river, that, at one time, it was seriously proposed to pump the necessary water by steam produced by natural gas, but the idea was abandoned in favor of a gravity system in open canals.

The dam is approximately 5,000 feet long and crosses the entire valley of the Bow which is, at that point, about 300 feet deep. The river is in two channels at high water and both were closed by a solid concrete spillway 14 feet high, and the intervening space filled by an earth dam 25 feet high with 1½ to 1 slopes on the upper side and 1½ to 1 slopes on the downward side. The face of this earth fill was heavily riprapped with

river boulders to prevent scour and wave wash. The foundations were carried to a depth of about ten feet where a heavy blue gumbo clay was found and both the earth fill and the concrete spillways were securely embedded in this. The headgates are of concrete with sliding steel gates raised and lowered by a rack and pinion and may be operated by hand or by power. The main canal is 25 miles long and leads from the river to a reservoir 35 miles long and averaging two miles wide, made by damming both ends of a valley. The canal is 25 feet wide on the bottom and carries at full capacity, six feet of water.

When this system is finally completed, it will open for settlement a large part of the last of the open, free range which the cattlemen have heretofore enjoyed.

Small Systems

Throughout Southern Alberta there are several small private irrigation systems built and operated by private parties for their own benefit. The Bar-U ranch near High River has several hundred acres of timothy and alfalfa under irrigation, and the Conrad Circle Cattle Co. have two dams and reservoirs on their home ranch south of Gleichen, Alberta, from which they watered several hundred acres of grain and hay as well as root crops and garden. Along the Highwood river and numerous other streams which come down from the foothills, there are a great many of these small private systems, which are the result of the settlers experiencing irregularity of rainfall. These small systems are responsible for some of the enormous crops of roots and hay which come from these creek and river bottoms.

Canadian Pacific Irrigation Block

The largest and most important in point of size and engineering skill in Canada, and probably the largest block of irrigable land under one irrigation system on the North American continent, is that of the Canadian Pacific railway immediately east of Calgary, Alberta.

In order to appreciate the influence which this great work has had on the development of Southern Alberta, it must be remembered that, six years ago, the entire territory between Calgary and Medicine Hat was without settlement of any kind, with the exception of one small town known as Gleichen. This place was a shipping point for the cattle interests. The distance between the two points was approximately 180 miles and the land traversed has since proven, with the aid of the water supplied, to be of exceptional fertility. The Company could, under the terms of its grant, select alternate sections throughout the block. The income from 180 miles of railway was practically nothing. It had been demonstrated by surveys made by the Department of the Interior that a very large portion of this land was susceptible of irrigation. The matter was taken up by the officials

of the Canadian Pacific railway, and, after considerable discussion, they decided to have a report from a consulting engineer with a view to ascertaining the possibilities of the tract. After this report was received, negotiations were entered into with the Dominion Government with a view to obtaining the balance of their land grant in a solid block. These negotiations were successful and the result was the acquisition of a block of land lying between the Red Deer river and the Bow river and from the Eastern boundary of Range 11, West of the 4th Meridian to the 5th Meridian, which is about a mile east of the city of Calgary. This block contained a few hundred acres over three million. The Company then began to ascertain the exact amount of land which could be irrigated. For convenience in handling, the block was divided into three sections, each comprising one million acres. As it was decided to irrigate the Western section first, the intake of the main canal was constructed on the Bow river about two miles below Calgary.

West. Section Can. Pac. Irrigation Block

Further topographical surveys developed the fact that out of the total area of this section—one million acres—about 36 per cent. could be irrigated.

The main channel for the Western section leaves the Bow river and follows an old back channel very closely, to the foot of the 'cut bank' on the east side of the Bow for a distance of approximately two and a half miles. At this point a ridge of gumbo and gravel was encountered, which necessitated the moving of about 750,000 yards of material to get through it. This waste material was hauled backward and put into a fill which practically paralleled the 'cut bank,' the entire distance between the head gates and the ridge referred to, and which formed the outer bank of the canal. From this point on, the canal followed an old river channel for a distance of approximately three miles, at which point the canal grade reached the bench and very rapidly left the banks of the Bow, as that stream falls at the rate of 25 feet per mile, while the canal falls only one foot per mile. After reaching the bench or level prairie, the canal continues in a north-easterly direction until it reaches a point approximately 16½ miles from its head gates, where it empties into what is known as Reservoir No. 1, or Chestermere lake. This canal is 44 feet wide on the bottom, 84 feet on the water-line, 10 feet normal depth and is designed to carry approximately 2,100 cubic feet per second. The banks, however, are four feet higher than the normal depth of water—ten feet—and thus, a larger amount than the calculated capacity may be carried. This canal should not be considered as an irrigation ditch as there is no water taken from it directly onto the land. It is a transportation channel only and, delivering its water as it does into Chestermere lake, may be said to be designed only for that purpose.

From Chestermere lake, which is a depression in the prairie dammed at one end, radiate what are known as secondary canals. There are three of these, A, B and C, and from them, lead the distributing canals to the different parcels of land. Secondary canal A takes care of most of the land lying on the Bow slope, or that portion of the watershed which drains into the Bow river. At its head, it is a canal 18 feet wide on the bottom and carrying water to a depth of eight feet. It is approximately 65 miles long; has tributary to it about 500 miles of distributing canals and supplies water for 140,000 acres of irrigable lands.

Secondary canal B takes water to the central portion of the Western section which lies in a valley running almost east-and-west to the centre of the block. It is not as large as Secondary canal A in point of water carried, but owing to the necessity of flat grades at different points, it is much larger in point of excavation. It provides water for about 90,000 acres of land; is 28 feet wide on the bottom and 8 feet deep.

In the Western section, the following mileage of waterways has been constructed:—

	Miles
Main canal	17
Secondary canals	254
Distributing ditches	1,329
	1,600

In addition to the above, there are hundreds of miles of small ditches constructed by the farmers to distribute the water over their farms.

Secondary canal C supplies the land lying in the northern portion of the Western section lying along the Red Deer river and easterly for a distance of about 45 miles. It has tributary to it 130,000 acres of irrigable land; is 40 feet wide on the bottom and 8 feet deep.

All these canals are bridged at every road crossing with pile bridges, and all the structures, including drops and head gates on the secondary canals, are of timber, but under Secondary canal C, and, in a few instances under A and B, the structures in the distributing ditches or small canals which take the water to the land, are of concrete, reinforced to prevent the possibility of cracking from the action of the frost; for they have no foundation except the heavy clay in which they are embedded. In operation these have proven vastly superior to wooden structures of a similar nature and, no doubt, in any future construction, they will be used entirely.

It may be noted here that this scheme differs from any heretofore designed inasmuch as it provides water at the highest possible

point in each quarter section, a thing which has never been provided by any system before. It is doubtless owing to this fact that the development of the Western section has been so rapid.

In designing the system, the aim was to make the maximum number possible of what are known as combination farms, that is to say farms with about an equal area of irrigable and non-irrigable land, and this idea has been carried out throughout the whole block. It should be noted that irrigable land under this system includes all land lying at a lower elevation than the point of delivery, whereas the general classification of irrigable land in other schemes comprises all that lying at a lower elevation than the distributing canal from which the water is drawn. It will be seen from this that combination farms were made quite possible, and land which, under any other system of classification would have been irrigable, is classed as non-irrigable.

The land was put on the market in 1907, and, in spite of the endeavours of the engineers to classify the land, it was necessary, early in 1909, to stop the sales until more could be classified. There is no doubt that the classification of land in the manner described above is responsible for the remarkable sales, and for the wonderful development which has taken place throughout the western section. Of the total area—irrigable and non-irrigable—only 5 per cent. remained unsold in September, 1911. The water was turned into this canal in 1906, and ran the entire distance of the main canal and Secondary canal A without serious accident.

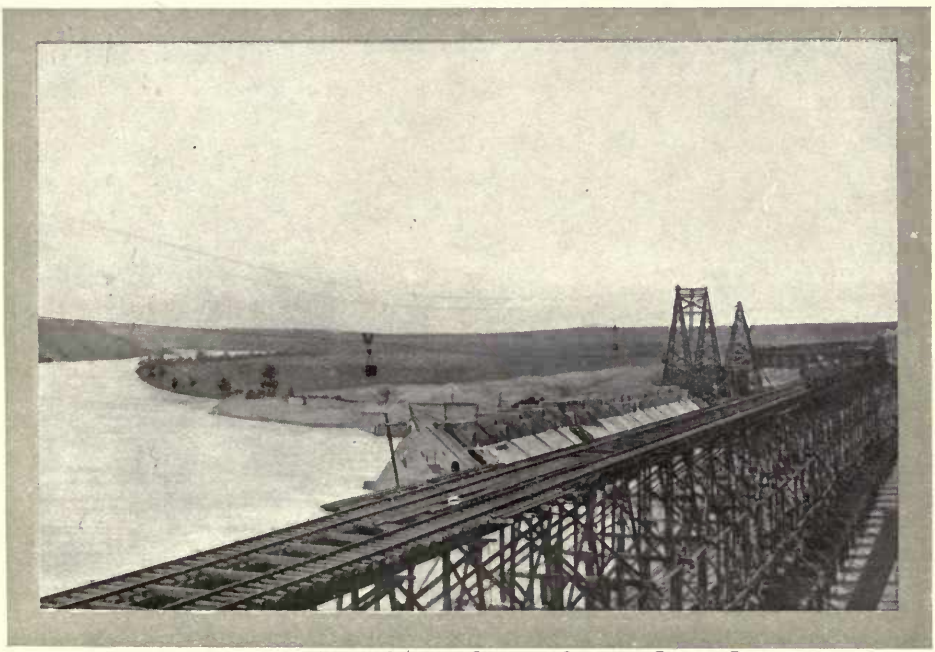
For the convenience of British settlers, the "ready-made" farm scheme was devised. The Company developed a certain number of farms, broke the land, put in the crops, built houses and barns, erected fences, and, in many cases, planted a crop, so that the settler, on arrival, had only to buy his household goods, live stock, implements, etc., and, practically, begin life where he left off on his old farm in England or Scotland. This has proved to be very successful and the demand for these "ready-made" farms has exceeded the supply many times over. The payments for this development work are included in the payments for the land. The total payment is divided up into ten annual instalments, which cover the price of the land and buildings, but do not include the charge for water, which is payable each six months.

East. Section Can. Pac. Irrigation Block

The Eastern section contains 1,156,224 acres of which 440,000 will be irrigated. Most of the land is gently rolling and susceptible of good drainage.

This system is independent of the Central and Western sections. The intake is situated on the Bow river, three miles southwest of Bassano and 83 miles east of Calgary. Advantage is taken of a low pass through the

MAIN CANAL, EASTERN SECTION, CANADIAN PACIFIC RAILWAY IRRIGATION BLOCK.
AUG. 10, 1911.



BASSANO DAM, BOW RIVER, EASTERN SECTION CANADIAN PACIFIC RAILWAY
IRRIGATION BLOCK. AUG. 10, 1911.

rim of the Bow valley at "Horseshoe Bend." The dam under construction at this point, will raise the water 46 feet, giving a normal depth of water in the canal of 11 feet. It is a composite structure consisting of a reinforced concrete spillway in the present river channel and of an earth embankment 1⅓ miles long. The earthen portion has a maximum height of 45 feet, and a maximum width at the base of 350 feet.

The main canal is 70 feet wide at the bottom and, when carrying 11 feet of water, will have a capacity of 3,000 cub. ft. per sec. Five miles from the intake it will discharge into a reservoir formed by the construction across the valley of an earthen dam nearly a quarter of a mile long and 35 maximum height.

From this reservoir the North Branch canal—30 feet bed width and carrying 6½ feet of water—will serve the country north and east of Matziwin creek. North of the railway, it will follow the west flank of Crawling valley, and, eight miles from its intake, will cross the valley by a siphon or flume. Thence, it will run northerly to its termination at Red Deer river.

The East Branch canal—70 feet bed width and carrying 9·3 feet of water—will serve the remainder of the Eastern section. The first branch, the Spring-hill canal, leaves the East Branch at Lathom and waters a large area between the two forks of Matziwin creek. It has a bed width of 35 feet and carries 7 feet of water. The East Branch canal reaches the divide between the Bow and the Red Deer at the head of Antelope creek. At this point, it divides, the southeasterly branch—the Bow Slope canal—carrying 5 feet of water and 17 feet bed width, serving all the land in the Bow River slope. At Cassils, two smaller canals will be taken off and, just south of Brooks, the East Branch will discharge part of its water into Lake Newell reservoir occupying a depression in the Little Rolling hills. Lake Newell will have a storage capacity of about 185,000 acre feet and is formed by the construction of a number of dams, the largest of which will be two-fifths of a mile long and 30 feet high.

The remainder of the East Branch water will be carried along the east flank of the Rolling hills in the Rolling Hills canal, 20 feet bed width and carrying 5½ feet of water.

The outlet from lake Newell will be a canal 40 feet bed width, carrying 7 feet of water and five miles long. At its easterly end, it will discharge into a siphon or flume, two miles long, which will carry the water over the divide and deliver it to the Bantry canal. The latter will serve the country north and south of the Bantry hills. It will have a bed width of 45 feet and will carry 7½ feet of water.

The Eastern Section system is a very large undertaking and includes many large and important structures. To ensure permanency, reinforced concrete or other permanent construction will be used in all important

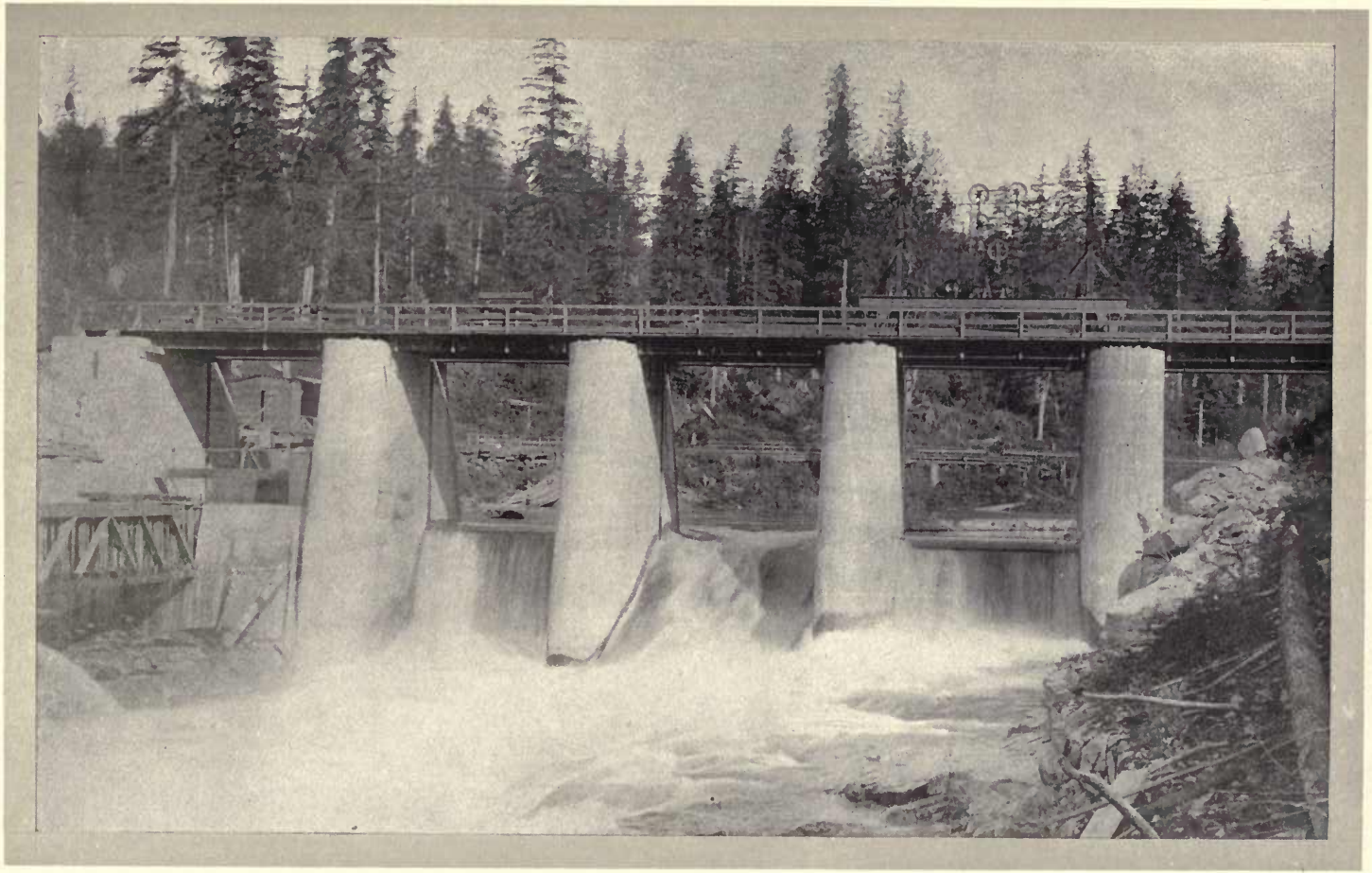
structures. The estimated mileage of canals and ditches in this section is as follows:

	Miles
Main canal	5
Secondary canals	475
Distributing ditches	2,020
	2,500

The earth work in connection with the excavation of the above canals and ditches will aggregate upwards of 20 million cub. yds., the whole of which is now (Sept. 1911) under contract.

Central Section

This contains an area of 901,737 acres, of which it is proposed to irrigate about 70,000 acres. The preliminary surveys are now about completed, and the non-irrigable areas are being rapidly disposed of. The irrigable lands in this section will be served through an enlargement of the system already constructed to serve the Western section of the Block, the head-works of which are situated near Calgary.



STAVE FALL, BRITISH COLUMBIA

CHAPTER X

British Columbia

AS the population of British Columbia is concentrated in the southern portion of the Province the water-power development, thus far, consists of a few plants near the two principal cities, viz., Vancouver and Victoria, and a few in the so-called, Boundary district. Some additional plants are projected or under construction along the main line of the Canadian Pacific railway but fully ninety-five per cent. of the powers are either unknown or have not been gauged.

Disposal of Water-Powers

Statutory Enactments

The water-powers of the Province are disposed of under the provisions of the Water Act,* which was enacted in 1909 to amend and consolidate the laws relating to the acquisition and use of water.

The following is a synopsis of this Act with amendments up to and including March, 1911, so far as it relates to the disposal and use of water for power purposes.

The Act is divided into seventeen parts as follows:

Part I—Confirming to the Crown the ownership of all water

Part II—The Unit of Measurement

Part III—The Determination of Existing Rights and Claims and the Creation of a Tribunal for that Purpose

Part IV—Priority of Purpose and of Right in Acquisition of Water

Part V—Procedure to obtain Water Licenses and the general Rights acquired by the Licensee

Part VI—Procedure to obtain Approval of Works

Division (1) By Licensees taking and using a small quantity of Water on their own land for other than Power Purposes

Division (2) By other Licensees taking and using Water for any Purpose

Part VII—General Powers and Privileges of Municipalities and Companies using Water for Domestic Purposes

Part VIII—Special Powers and Privileges of Municipalities using Water for Domestic Purposes

Part IX—Powers and Privileges of Power Companies

Part X—Municipalities as Power Companies

Part XI—Clearing streams for Driving Logs

Part XII—Storing Water

*Statutes of British Columbia, Chap. 48, 1909

Part XIII—The Taking and Using of Land

Part XIV—The Obligations, Duties and Limitations Imposed on Licensees

Part XV—Miscellaneous

Part XVI—Rules, Regulations and Penalties

Part XVII—Saving Clauses and Repeal

PART I: CONFIRMING TO THE CROWN THE OWNERSHIP OF ALL WATER.—The use of the unrecorded water of a stream belongs to the Crown. Riparian owners shall have the right to use such water for domestic purposes, but no right to the permanent diversion or to the exclusive use of any water shall be acquired by any riparian owner or by any other person by length of use or otherwise, unless the same may have been acquired under this Act.

PART II: THE UNIT OF MEASUREMENT.—The unit of measurement and quantity shall be the cubic foot and acre foot respectively.

PART III: THE DETERMINATION OF EXISTING RIGHTS AND CLAIMS.—The Chief Commissioner may divide the Province into Water Districts.

The Lieutenant-Governor in Council may appoint a Chief Water Commissioner and Water Commissioners for any one or more Water Districts.

A Board of Investigation is created, under this Act, for the purpose of hearing the claims of all persons holding or claiming to hold, records of water, or other water rights under any former public Act or Ordinance, of determining the priorities of the respective claimants, and of prescribing the terms upon which new licenses will be issued. The Board shall consist of the Chief Water Commissioner, and such other two or more persons as the Lieutenant-Governor may appoint.

The Board may cause to be made on each stream, in the order settled by the Board, a proper measurement of the low-water, high-water and flood discharge, and an examination of all the works constructed for conveying or utilizing water from each stream, and the report of such measurement and examination may be used by the Board when inquiring into and determining rights and claims upon any stream,

The Board shall fix the time and place for hearing claims and determining rights to water on each and every stream, and shall then give such notice thereof to the persons interested, but in no case shall less than ten days' notice be given.

The Board shall, by advertisement in some newspaper published or circulating in the District, give one month's notice of their intention that, on a certain date, they will proceed to adjudicate upon the claims to water on any certain stream, and directing all persons having claims to water on such stream, on or before a certain date, to come in and present their claims. No license shall be issued for water in respect of such stream,

STAVE FALLS, BRITISH COLUMBIA

after the date mentioned above, until after the Board has finally settled and determined the priorities of all claimants on such stream.

A claimant may bring on any claim before the Board by presenting a memorandum in writing, setting out:

(*a*) An exact copy of the record or records claimed;

(*b*) The area of land held to which it is claimed the water is appurtenant;

(*c*) The area of irrigable land held;

(*d*) The character and brief description of the works;

(*e*) Maps or plan (if any) in the possession of the claimant relating to the land or mine, or the water rights claimed;

(*f*) The purpose for which the water has been used;

(*g*) The quantity of water generally used by the claimant each year, expressed either in miner's inches, cubic feet per second, or acre feet;

(*h*) The quantity of water, expressed as aforesaid, that is claimed;

(*i*) Set out the title to the land held.

The Board shall, among other things:

(*a*) Examine the claim presented for their consideration, and hear evidence in support of and in opposition to each claim respectively;

(*b*) Determine the priorities of the respective claimants to water out of any particular stream;

(*c*) Establish such priorities by numbering them in their order and directing that entry be made in the Record of Licenses of the District accordingly, showing the priority and the issuance of a license to the company or person entitled thereto;

(*d*) In the case of water used for irrigation or mining purposes, determine the quantity of water to which each claimant shall, in their opinion, be entitled;

(*e*) Direct and establish the character of the works of each claimant, and herein have due regard to existing storage works;

(*f*) From time to time give such directions and make such orders as they may think necessary for the improvement of any works to prevent waste;

(*g*) Direct the officer having charge of the Record of Licenses to enter in a book kept for that purpose—

(1) The name and post office address of the company or person entitled to the water;

(2) The proper number of the licenses in the order of their priority;

(3) The quantity of water to which the company or person is entitled;

(4) The name of the stream;

(5) The point of diversion;

(6) A brief concise description of the works;
(7) The purpose for which the water is to be used;
(8) The name of the place where the water is to be used;
(9) If the license be for a limited time, then the period of time.

(*h*) Direct the cancellation of the old records.

Municipalities and companies holding records of water and whose works have been approved by the Lieutenant-Governor in Council, pursuant to the "Water Clauses Consolidation Act", shall be entitled to a license under this Act for the same quantity of water.

Where records of water have been given before May 8th, 1897, and no works have been constructed for the purpose of utilizing such record, the Board may grant the applicant a license. In such license, the Board shall state the fact of such non-utilization, and shall give the licensee one year to begin the actual construction of such works as the Board may think fit to order, and shall further state the time within which such works are to be completed.

If the works shall not be begun or completed on or before the date so fixed by the Board (unless such time has been extended by the Board) the license shall be null and void.

PART IV: PRIORITY OF PURPOSE AND OF RIGHT IN ACQUISITION OF WATER.—All licenses to use water shall issue with due regard to the purpose for which it is required, which shall have priority in the following order:

First—Domestic purposes;

Second—Municipal purposes, which shall mean and include the supply of water by any company to city; town, village, or unincorporated locality for domestic purposes;

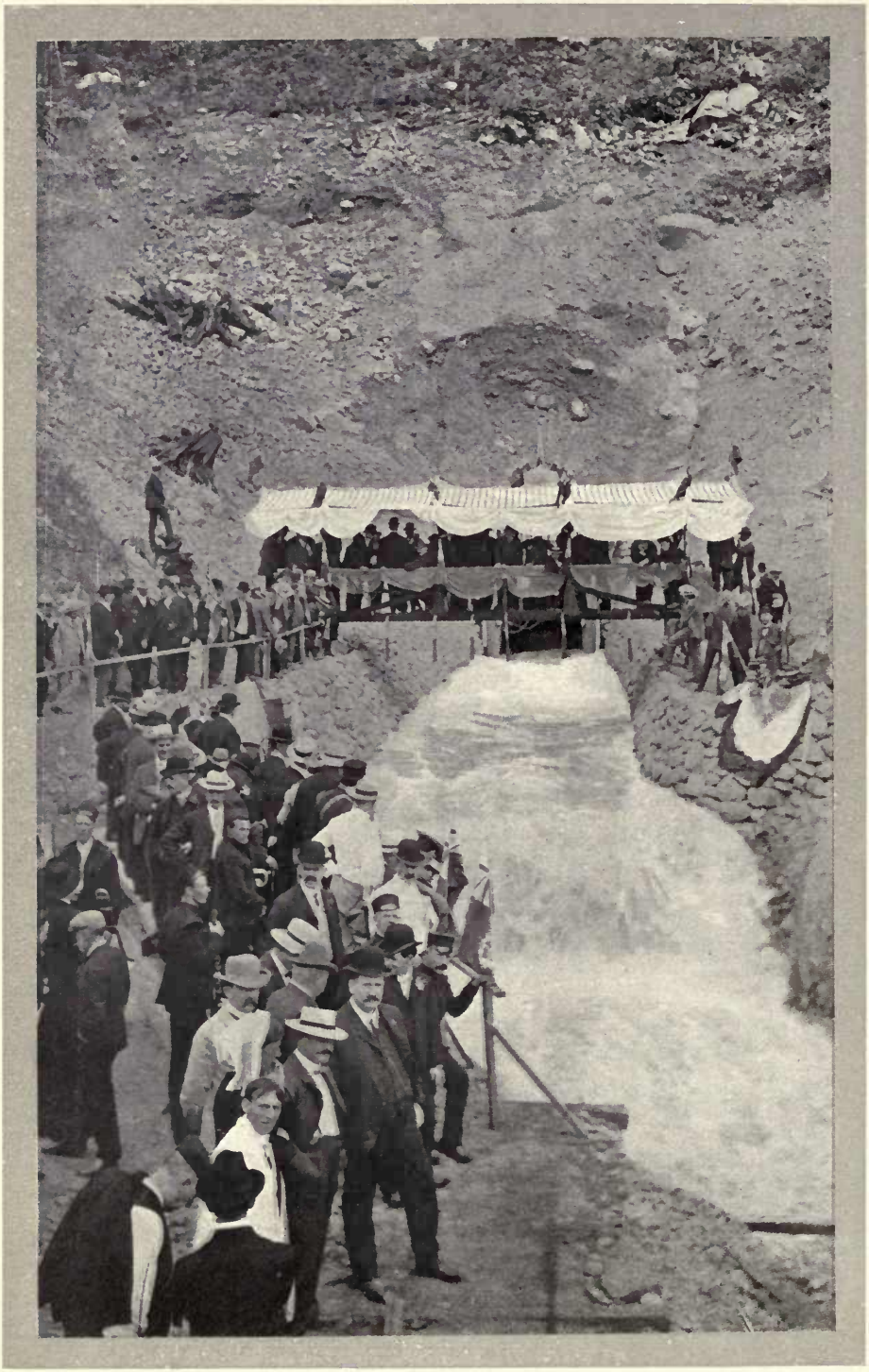
Third—Irrigation of land for agricultural or horticultural purposes;

Fourth—Industrial purposes, which shall mean and include water required for the production of steam and all other purposes save domestic, municipal, irrigation, the production of power for sale, barter or exchange, and mining;

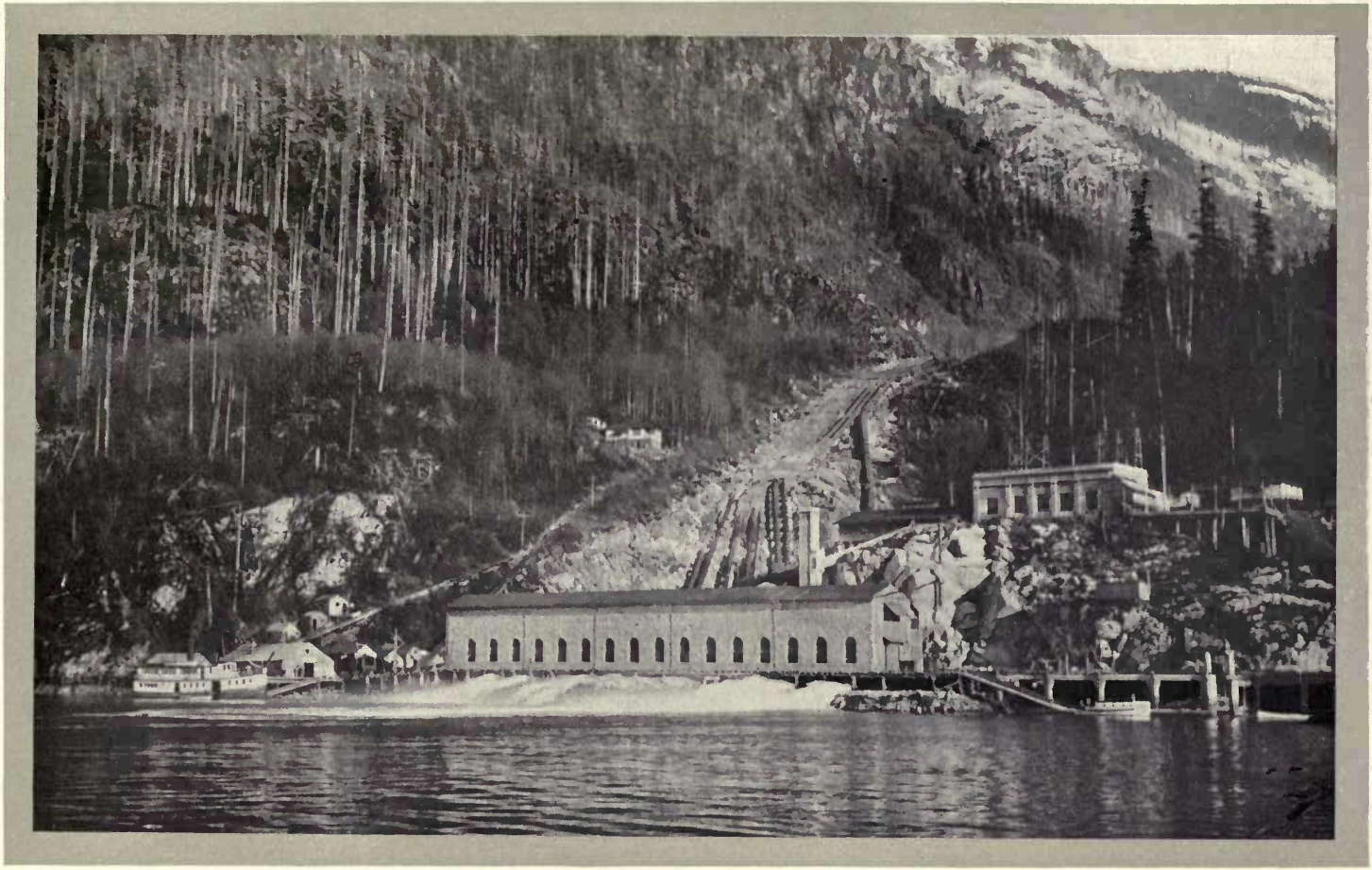
Fifth—Power, which shall include the use of water for generating power for sale, barter, or exchange.

PART V: PROCEDURE TO OBTAIN WATER LICENSES AND THE GENERAL RIGHTS ACQUIRED BY THE LICENSEES.—Save as aforesaid no license shall issue to any individual for the sale, barter or exchange of water. Licenses for these purposes shall issue only to the municipalities and companies that are either incorporated, licensed or registered in this Province.

Whenever application is made for the use of water on any particular hereditaments, no license shall issue unless the applicant holds the land.



OPENING OF VANCOUVER POWER COMPANY'S TUNNEL CONNECTING COQUITLAM LAKE WITH BUNTZEN LAKE, B C.



POWER HOUSE, NORTH ARM, BURRARD INLET, BRITISH COLUMBIA

Any municipality, company or person may acquire a license to divert any unrecorded water and store the same in any manner as provided for by this Act.

At least thirty days previous to applying, the applicant shall, at conspicuous points in the locality, post a notice of his intention to apply for a license. Such notice shall be on a form to be supplied by the Water Commissioner and a copy of the notice shall be filed in the office of the Water Commissioner concurrently with publication of a notice in a newspaper. In addition to this notice, the applicant shall insert a copy of the notice forthwith and continuously for one month in some newspaper published in the Water District and in the immediate locality, and if the application be for more than four cubic feet per second, then a notice describing the right sought to be acquired, shall be inserted in the British Columbia Gazette. In the case of an applicant seeking water rights not exceeding eight cubic feet per second, for placer-mining purposes, the Water Commissioner may authorize the applicant to dispense with advertising.

No license shall issue for more than one purpose. When mentioned in the license, the licensee shall have the power to store water and to lower lakes and other standing bodies of water below their normal level.

The grant of a license shall entitle the holder to the flow of water specified therein. A licensee may enter upon Crown or other lands for the purpose of surveying the route for conveying water. The licensee shall, before entering upon the lands of private owners, give adequate security for the payment of any damage caused thereby.

Part VI: Procedure to Obtain Approval of Works:—Division 1.—Users of Small Quantities of Water for Other than Power Purposes.

When a license for not more than four cubic feet per second has been granted to an individual for the use of water on his own land for other than power purposes, the licensee shall forthwith proceed to survey and lay out the works proposed to be constructed and shall forward in duplicate, the map or plan of the works together with a description of the works to be constructed and the name and position of all private lands, roads, etc. crossed or touched by the proposed works. The licensee shall not proceed with the construction of the proposed works until the Water Commissioner has given written authority to proceed. Such works shall be completed within the time set by the Water Commissioner.

Division 2.—Licensees Using Water for any Purpose.

Any municipality or company for the purpose of supplying water to one or more municipalities or unincorporated localities, or any other company desiring to use water for any purpose may, from time to time, apply for and obtain in manner aforesaid one or more licenses to take, use and divert water.

Any company, individual or municipality that has obtained a license for more than four cubic feet of water per second for use on their own lands for other than power purposes shall, before proceeding with the construction of the proposed works, obtain the approval of the Lieutenant-Governor in Council to the proposed undertaking and works.

The Lieutenant-Governor in Council may issue a certificate, setting forth that the proposed undertaking and works has been approved, or that the same has been approved subject to division into parts, the alterations, limitations, restrictions and conditions to be set forth in such certificate.

If such certificate is issued to a Company, it shall contain further information relating to the capital which shall be subscribed and paid up before the company shall begin the construction of the works; or, if the work has been divided into parts, then the amount of capital to be subscribed and actually paid up in respect of each part, before beginning the works on each particular part; the time within which the work shall be begun, and if divided, then the time within which each part shall be begun; the time within which the works shall be completed and in operation; the area within which the company may exercise its powers.

Part IX: Powers and Privileges of Power Companies.—Any company having obtained the approval of the Lieutenant-Governor in Council to the undertaking and work of the company for power purposes, and a certificate of such approval having been granted, may, upon the terms and conditions mentioned in the certificate and subject to the provisions of this Act, enter upon and expropriate other lands. The company may construct their works on the lands referred to in the map or plan submitted to the Lieutenant-Governor in Council at the time when the application was made for the approval of the undertaking. In addition to the general powers conferred on all licensees, the company may construct, operate, maintain and repair houses, factories, shops, electric and power-plants and tramways, produce power, generate, transmit and supply electricity, compress air and supply same, and may erect and maintain poles, wires and other apparatus required for the above purposes. The company shall also have the power to sell or let for use, light, heat, power and any and all apparatus used for measuring same, to fix the rates and charges for the use of light, heat and power, and the carriage of goods and passengers.

Part X: Municipalities as Power Companies.—Whenever a municipality, pursuant to any authority conferred by any act of the Legislature of this Province, has passed a by-law or by-laws for any of the following reasons:

(*a*) For purchasing, constructing and operating works for supplying electric light or gas, and regulating the conditions and terms under which the same may be supplied and used;

(*b*) For purchasing, constructing and operating tramways, street railways, and ferries;

then such municipality may apply for a license to take and use water pursuant to this Act, and shall, if and when such license is granted, have all the rights, powers and privileges of a power company, and be subject to all the obligations of a power company.

PART XI: CLEARING STREAMS FOR LOG DRIVING.—Sec. 171 states—If as the result of the construction of any works by a licensee under this Part, any water-power is created, the licensee shall not by reason of such construction only, have any right, title or claim to use the power so generated.

PART XII: STORING WATER.—Any licensee whose license includes the right to store water, and whose works have been approved pursuant to Part VI, may proceed with the construction of the works necessary for such storage purposes and, pursuant to the Rules in that regard, the requisition of the land required. But the right to store water shall be subject to prior rights to its uninterrupted flow for so much as is required for actual use for domestic purposes.

When two or more licensees using the same reservoir for storing water cannot agree upon the quantity to be withdrawn by each, the quantity to which each is entitled shall be settled by the Water Commissioner.

PART XIII: THE TAKING AND USING OF LANDS.—No entry shall be made on the lands of private owners if the works can be reasonably constructed upon Crown lands without such entry.

The licensee shall before entering upon any private lands.—

(*a*) File in the Land Registry Office of the district a map or plan of the land intended to be entered upon or used;

(*b*) Serve the owner with a notice of such intended entry.

(*c*) Attach a description of the proposed works to the plan, and state the amount of compensation to be given.

In case of failure to arrive at an agreement as to the amount of compensation, the same shall be determined by arbitration.

PART XIV: THE OBLIGATIONS, DUTIES AND LIMITATIONS IMPOSED ON LICENSEES.—Without lawful authority, no licensee shall obstruct any navigable stream.

When water is not used beneficially by any licensee or is used in excess of the requirements of such licensee, any person may apply for a license and take and use so much thereof as the Water Commissioner may deem just to all parties.

A license shall be subject to cancellation if the powers granted under license be not exercised for three successive years; for waste; or for non-use of the privileges granted, save where such non-use has arisen from circumstances that were accidental or not wholly within the control of the licensee.

Every licensee shall with respect to the property of others do as little damage as possible.

Power companies shall not interfere with the public right of travelling or using any roads, streets or highways.

No undertaking or work of any municipality and no privilege appurtenant thereto shall be purchased by any other municipality or by any company under this Act except—

(*a*) With the consent of the municipality; or

(*b*) Under authority of an Order in Council made by the Lieutenant-Governor in Council upon its being made to appear that such taking or purchase is necessary in the public interest.

No land or works of any company under this Act shall be purchased by any other company engaged in constructing or operating similar work except in accordance with (*b*) above.

PART XV: MISCELLANEOUS.—The Lieutenant-Governor in Council may at any time, by notice signed by the chief Commissioner and published in the British Columbia Gazette, reserve the unrecorded water in any stream for the use of the Crown or for municipal purposes. Licenses may be obtained for the purpose of using such reserved water in the interim prior to the establishment of such a system; but no rights to compensation shall be acquired by virtue of any license so issued.

Water-Powers in the "Railway Belt" and Peace River Block

The provisions of the Dominion Lands Act (1908) do not apply to the public lands comprised within the British Columbia "Railway Belt." The provision excluding this area was inserted pending a decision by the Imperial Privy Council respecting the ownership of the water-powers therein, whether they belonged to the Dominion or to British Columbia. In November, 1910, the Privy Council decided that the title was vested in the Dominion.

The text of the decision is as follows:

"This is an appeal, by special leave, from the judgment of the Supreme Court of Canada, affirming a judgment of the Exchequer Court of Canada rendered on the 10th May, 1909.

The only question raised upon the appeal is whether certain water rights in the Railway Belt of British Columbia are vested in the Dominion Government so as to preclude the Provincial Legislature from dealing with them. The circumstances in which the dispute has risen are shortly as follow. The Province of British Columbia was admitted into the Dominion of Canada in the year 1871 under the provisions of the British North America Act, 1867. The admission was subject to the provisions of that Act and also to certain Articles of Union duly sanctioned by the Parliament of Canada and by the Legislature of British Columbia. The 11th of these Articles stipulated that the Dominion Government should secure the construction of railway communication between the railway system of Canada and the seaboard of British Columbia, and that the Government of British Columbia should convey to the Dominion Government "in trust to be appropriated in such manner as the Dominion Government may deem advisable in the furtherance of the construction of the said railway," certain public lands along the line of railway throughout its entire length in British Columbia. In consideration of the land to be so conveyed in aid of the construction of the said railway the Dominion Government agreed to pay to British Columbia from the date of the union the sum of $100,000 per annum. The conveyance contemplated by this part of the 11th Article was effected by subsequent statutes of the Legislature of the Province and the land so conveyed is known as the "Railway Belt." The railway has now been built.

By the Water Clauses Consolidation Act, 1897, 61 Vict., chap. 190 (Revised Statutes of British Columbia) section 4, the right to the use of the unrecorded water in any river, lake, or stream was declared to be vested in the Crown in the right of the Province, and it was enacted that save in the exercise of any legal right existing at the time of such diversions or appropriation no person should divert or appropriate any water from any river, watercourse, lake, or stream, excepting under the provisions of the Act. By section 5 it was provided that no right to the exclusive use of such water should be acquired by any person by length of use or otherwise than as might be acquired or conferred under the provisions of the Act or of some existing or future Act. By section 2 "water" was declared to mean all rivers and water-power not being waters under the exclusive jurisdiction of the Parliament of Canada and "unrecorded water" was declared to mean all water not held under a record under the Act or under certain repealed Acts or under special grant by public or private Act and should include all water for the time being unappropriated or unoccupied or not used for a beneficial purpose.

On the 7th April, 1906, the Water Commissioners for the district of New Westminster, British Columbia, purporting to act under the provisions of this Act, granted to the appellants, the Burrard Power Company, Limited, at an annual rental of $566, a water record for

25,000 inches of waters out of the Lillooet Lakes and the Lillooet River to be used for generating electricity. These waters are within the Railway Belt.

On the 26th December, 1906, the Attorney General for the Dominion of Canada filed an information in the Exchequer Court of Canada against the Power Company, claiming a declaration that the record was invalid and conveyed no interest to the Defendant Company and asking that the same should be cancelled. The information (which will be found set out on pages 717, 718 and 719 of the Record) alleged that the works of the Power Company if carried out would have the effect of diverting the water of the river, thereby interfering with its navigation, and would otherwise materially diminish the value of the lands of the Dominion Government in the Railway Belt. In support of the claim reliance was placed on the agreement contained in the Terms of Union, and on the provisions of the Acts of the Provincial Legislature passed for the purpose of giving effect to that agreement. Reliance was also placed on the provisions of section 91 of the British North America Act, 1867, which declares that the exclusive legislative authority of the Parliament of Canada shall extend to all matters coming within certain classes of subjects, including the Public Debt and Property and Navigation. It was further submitted, that having regard to sub-section 2 of section 131 of the Water Clauses Consolidations Act, 1897, the grant of the record by the Commissioners was not authorized by the Water Clauses Act.

After the filing of the information the Attorney General of British Columbia was added as a party to represent the interests of the Province.

On the 23rd December, 1907, the determination of the issue of fact was referred for enquiry and report to Mr. Justice Archer Martin, who found the facts to be in accordance with the allegations of the Dominion Government and reported accordingly. Thereupon the Attorney General of Canada prayed judgment as asked by the information. On the 13th April, 1909, the case came on for argument before Mr. Justice Cassels, and on the 10th May, 1909, that learned judge declared that the grant of the record of water in question was invalid and conveyed no interest to the defendant company. The judgment proceeded on three grounds: first, that the grant was an interference with property subject to the exclusive authority of the Dominion of Canada; secondly, that the diversion of water intended to be authorized thereunder would be a very serious interference with the navigability of the river; and thirdly, that the record was not authorized by the provisions of the Water Clauses Act under which it had been granted. The judgment as drawn up will be found at page 715 of the Record. From this judgment an appeal was brought to the Supreme Court of Canada. The appeal was dismissed on the 15th February, 1910.

Their Lordships are of opinion that the judgments of the Courts below are right. The grant by the Province of British Columbia of "public lands" to the Dominion Government undoubtedly passed the water rights incidental to those lands. In the argument addressed to their Lordships this was not really questioned. But it was said that though the proprietary rights of the Province in the

land and in the waters belonging thereto were transferred to the Dominion Government, the legislative powers of the Province over the same, neither were nor could be parted with, and that therefore it was competent for the Provincial Legislature to enact the Water Clauses Act of 1897 under which the record was granted. In support of this contention a passage was cited from the judgment of Lord Watson in *the Attorney General of British Columbia vs. the Attorney General of Canada* (1889), 14 Appeal Cases, p. 301. Their Lordships are of opinion that the contention is wrong, and that the passage in Lord Watson's judgment affords no kind of support for it. The object of Article II of the Terms of Union was on the one hand to secure the construction of the railway for the benefit of the Province and on the other hand to afford the Dominion a means of recouping itself in respect of the liabilities which it might incur in connection with the construction by sales to settlers of the land transferred. To hold that the Province after the making of such an agreement remained at liberty to legislate in the sense contended for would be to defeat the whole object of the agreement, for if the Province could by legislation take away the water from the land it could also by legislation resume possession of the land itself; and thereby so derogate from its own grant as to wholly destroy it. Lord Watson's reference in the Precious Metals Case to the 11th Article so far from supporting the appellants' contention is against it. He says, "the conveyance contemplated was a transfer to the Dominion of the provincial right to manage and settle the lands and to appropriate their revenues." The grant of the water record in the case now under consideration is an attempt on the part of the Province to appropriate the revenues to itself, and would if carried into effect violate the terms of the contract as interpreted by Lord Watson. It is true that Lord Watson adds that the land is not by the transfer taken out of the Province, and that once it is "settled" by the Dominion it ceases to be public land, and "reverts to the same position as if it had been settled by the Provincial Government in the ordinary course of its administration." But this also is against the appellants' contention, for it implies that until settled by the Dominion it remains public land under the Dominion's control.

Their Lordships are of opinion that the lands in question, so long as they remain unsettled are "public property" within the meaning of section 91 of the British North America Act, 1867, and as such are under the exclusive legislative authority of the Parliament of Canada by virtue of the Act of Parliament. Before the transfer they were public lands, the proprietary rights in which were held by the Crown in right of the Province. After the transfer they were still public lands, but the proprietary rights were held by the Crown in right of the Dominion, and for a public purpose, namely, the construction of the railway. This being so no Act of the Provincial Legislature could affect the waters upon the lands. Nor, in their Lordship's opinion, does the Water Clauses Act of 1897 purport or intend to affect them; for, by clause 2, the Act expressly excludes from its operation waters under the exclusive jurisdiction of the Dominion Parliament.

Their Lordships will humbly advise His Majesty that the appeal should be dismissed with costs.

As a result of this decision, a Bill, No. 124, to provide for the water-powers in the Railway Belt and Peace River Block, is now (July 1911) before the House of Commons. The provisions of this Bill are as follows:

1. This Act may be cited as *The Railway Belt Water Act.*

2. In this Act, unless the context otherwise requires,—

(*a*) "domestic purposes" means and includes household, sanitary and fire protection purposes and the purpose of watering live stock;
(*b*) "municipal purposes" means and includes the supply of water to any city, town, village or locality, whether incorporated or unincorporated, for domestic purposes and street sprinkling;
(*c*) "irrigation purposes" means and includes the use of water for all agricultural and horticultural purposes and the sale or barter of water for such purposes by any person or municipality;
(*d*) "steam and manufacturing purposes" means and includes the use of water for the production of steam for working railways, steam factories and other machinery propelled by steam or for any manufacturing or industrial process;
(*e*) "power purposes" means and includes the use of water for generating power for any purposes whatever, and includes the storage, transmission, application, distribution and sale or barter of such power or of electricity obtained by means of such power for any purpose whatever;
(*f*) "mining purposes" means and includes the use of water for any purpose in connection with the developing or working of a mine, but does not include the sale or barter of water for any such purposes;
(*g*) "lumbering purposes" means and includes the clearing, control and use of lakes, rivers, streams, creeks and other waters in so far as may be necessary for driving and storing logs and other timber;
(*h*) "Minister" means the Minister of the Interior;
(*i*) "Railway Belt" means the lands granted to the Crown in the right of Canada by sections 2 and 7 of chapter 14 of the Statutes of British Columbia of 1884 for the purpose of constructing and to aid in the construction of the Canadian Pacific Railway;
(*j*) "riparian proprietor" means a person lawfully occupying lands adjoining and bordering upon any lake, river, stream, creek or other body of water or waterway within the Railway Belt;
(*k*) "works" means and includes all dykes, dams, weirs, flood-gates, measuring devices, breakwaters, drains, ditches, canals, basins, reservoirs, tunnels, bridges, culverts, cri embankments, head-works, flumes, aqueducts, pipes, pumps, and all contrivances for holding, carrying, or conducting water, and the power-houses and other buildings and structures required in connection with the development or utilization of water-power and all contrivances for holding or carrying transmission wires or pipes and all other works which are authorized to be constructed under this Act or under any regulation made pursuant thereto.

3. The property in and the right to the use of all the water at ny time in any river, stream, watercourse, lake, spring, creek, ravine,

cañon, lagoon, swamp, marsh, or other water within the Railway Belt shall for all purposes be deemed to be vested in the Crown, unless and until and except only so far as some right therein or in the use thereof inconsistent with the right of the Crown, and which is not a public right common to the public, is established.

(2). No grant made by the Crown of lands in the Railway Belt or of any interest therein shall vest in the grantee any exclusive or other right, title or privilege in, to or in respect of any river, stream, watercourse, lake, spring, creek, ravine, cañon, lagoon, swamp, marsh or other body of water, or in, to or in respect of the bed or shores of any such river, stream, watercourse, lake, spring, creek, ravine, cañon, or other body of water, saving only the right of every grantee to appropriate in the ordinary manner so much of the water as to which he is a riparian proprietor as may be reasonably necessary for his domestic purposes.

4. No right to divert, or, except for domestic purposes, to use any water from any river, stream, watercourse, lake, creek, spring, ravine, cañon, lagoon, swamp, marsh or other body of water or to the use of any land or shore underlying or adjacent to any water within the Railway Belt shall be granted or acquired otherwise than by license under regulations made pursuant to this Act.

5. All such licenses shall be issued with due regard to the purposes for which they are required and according to the following order, except in so far as such order is varied by regulation or by direction of the Minister: First, licenses for domestic purposes; second, licenses for municipal purposes; third, licenses for irrigation purposes; fourth, licenses for steam or manufacturing purposes; fifth, licenses for power purposes; sixth, licenses for mining purposes; seventh, licenses for lumbering purposes.

6. Any person having a license under this Act to take, divert, store, use, distribute or sell, water or power or electricity generated for any purpose from water, may take and acquire any lands or easements or any rights or privileges with respect to lands or affecting riparian rights which may be reasonably required in connection with the taking, diversion, storing, using, distributing or disposing of such water, power or electricity: Provided that no such lands, easements, rights or privileges shall be compulsorily taken or acquired unless or until the person desiring to take or acquire the same has first obtained the approval of the Governor in Council in such manner and subject to such conditions as may be prescribed by regulations made pursuant to this Act.

2. In and for all purposes connected with the taking or acquiring of any lands, easements, rights or privileges so authorized to be acquired or taken the provisions of *The Railway Act* as to the taking, acquiring or using of lands and making compensation for lands shall apply as nearly as may be and so far as applicable and not inconsistent with this Act or with regulations made thereunder.

3. For the purpose of the acquisition by His Majesty of any lands or of any rights or privileges connected with lands or any interest therein or of any works required in connection with the taking, diversion, storing, using, distribution or disposal of water, power or electricity, *The Expropriation Act* shall apply, so far as applicable and not inconsistent with this Act or with regulations made thereunder, and any powers which by *The Expropriation Act* are conferred upon a Minister may be exercised by the Minister of the Interior.

7. The Governor in Council may make regulations—

(*a*) for the issue of licenses for the storing or use of water, and for the use and occupation of the beds and shores of the waters aforesaid and for the construction of works in connection with the use of water in the Railway Belt.;

(*b*) for regulating the order and priority to be observed in the issue of licenses for the various purposes named in this Act;

(*c*) prescribing the several forms in which the licenses shall be issued, the terms and conditions upon which they shall respectively be granted, and the payments, fees, charges, rents, royalties and dues to be paid by the applicants for and by the holders of such licenses;

(*d*) for preventing the use or occupation of any of the beds, shores or waters aforesaid, except as authorized under this Act;

(*e*) for the determination, recognition and confirmation of existing rights, records, powers, privileges and priorities which have been exercised or enjoyed by any person;

(*f*) for defining the powers, duties and jurisdiction of any officers or persons necessary to give effect to this Act;

(*g*) for carrying out this Act.

Water-Power Districts

For the purpose of reference, the Province has been divided geographically into the following water-power districts:

I. Columbia River watershed.
II. Fraser River watershed.
III. Vancouver Island watersheds.
IV. Pacific Coast watershed.
V. Northern and North-eastern watersheds.

The areas of the principal drainage systems within these districts are as follows:

1.	Columbia river and tributaries (flows into Pacific ocean in United States territory.)	41,220	sq. miles.
2.	Fraser river and tributaries	87,318	" "
3.	Area of Vancouver island	12,900	" "
4.	Rivers that flow into the Pacific ocean		
	Taku river	7,860	" "
	Stikine river	18,828	" "
	Nass river	8,778	" "

Skeena river.....18,678 sq. miles

5. Rivers in north and north-eastern portion:
   - Peace river.....47,958 " "
   - Liard river (tributary of the Mackenzie).....52,806 " "
   - Hay river (flows into Great Slave lake,..... 5,145 " "
   - Lewes and Teslin rivers (tributaries of the Yukon)..... 9,630 " "

Principal Power Developments

Vancouver

The principal power developments in the vicinity of the city are the North Arm and Stave Falls power plants.

The North Arm plant is operated by the Vancouver Power Co., a subsidiary company of the British Columbia Electric Railway Co. The power developed by this plant is utilized and distributed by the parent company and is employed for lighting, power and street railway and inter-urban railway operation in the lower mainland of British Columbia, especially in Vancouver and vicinity, New Westminster and the Fraser valley east of New Westminster. The power plant is situated on the North arm of Burrard inlet. Buntzen lake, a small sheet of water over 400 feet above the plant, is utilized as reservoir, the water being diverted from Coquitlam lake and carried through a tunnel 12,775 feet long—stated to be the longest purely hydro-electric tunnel in the world. The present installation in the power house consists of six units, four of 3,000 H.P. each, and two of 10,500 H.P. each; a total of 33,000 H.P. The wheels operate under a head of 400 feet.

The Stave Falls plant is under construction by the Western Canada Power Company and will be completed in 1911 or early in 1912. This development is situated at the Upper Stave River falls, about six miles north of the confluence of the Stave and Fraser rivers at Ruskin, and seven miles south of Stave lake. Stave river is a large glacier-fed stream, discharging Stave lake, a sheet of water nine miles long and about one mile wide. Between the lake and the Upper falls, there is a descent of eleven feet which will be "drowned out" by the dam. At Upper Stave falls the river has a fall of eighty feet. When completed the plant will have a head ranging from 100 feet at low water to 120 feet at high water. "With an average head of 110 feet, a flow of 300 cubic feet per second will produce 28,000 electrical horse-power continuously, and under usual operating conditions a peak load of 44,000 to 48,000 H.P. can be provided for."* The company also owns a water right below the present plant where, by the construction of a dam 120 feet high in a narrow, rocky gorge, an equal amount of power can be developed. With a complete installation, a peak

*Information received from the Western Canada Power Co.

load of 100,000 H.P. could be carried. The present power house will contain an installation of two 13,000 H.P. turbines and two 7,500 K.W. generators and is designed to comprise double the present installation. The power will be transmitted at 60,000 volts to the receiving station near Vancouver, 35 miles distant; from the receiving station, it will be delivered to a number of small sub-stations, located in various convenient centres of distribution in Vancouver, North Vancouver, South Vancouver, New Westminster Burnaby, Port Moody and Coquitlam; whence it will be distributed at 2,000 volts.

Victoria

The principal power developments in the vicinity of the city of Victoria are the Goldstream and Jordan River power plants. Both plants are operated by the British Columbia Electric Railway Company.

The Goldstream watershed is situated about seventeen miles north-west of Victoria. The water is collected in five storage reservoirs and led by means of stream-bed and ditches to the forebay reservoir; from the forebay reservoir it is carried in a 33-inch steel pipe line 8,000 feet in length, to the power house. The power house equipment consists of a 4,600 H.P. turbine operating under a head of 650 feet and a 2,900 K.W. generator together with the necessary step-up transformers, etc.

The Jordan River watershed is situated about 45 miles north-west of Victoria. The water is collected in storage reservoirs and led to the forebay by natural stream bed and a wooden flume nearly six miles long; from the forebay reservoir the water is carried to the water-wheels by a steel pipe line 9,000 feet in length. The power house equipment consists of a 6,000 H.P. turbine operating under a head of 1,150 feet, a 4,000 K.W. generator with the necessary step-up transformers, etc. The ultimate capacity of this development will be 24,000 H.P.

The most important power development in the interior of British Columbia is that of the West Kootenay Power & Light Company. This company owns and operates the South Kootenay Water Power Co., the Cascade Water, Power & Light Co., the Rossland Water & Light Co. and the Okanagan Water Power Co. Power and light are furnished to Trail, Rossland, Grand Forks, Phœnix, Greenwood and Boundary Falls, the smelters and mines forming much the largest consumers.

The Company owns three power plants in all, viz.: (1) Lower Bonnington Falls, (2) Upper Bonnington Falls, (3) Cascade. The Upper Bonnington plant is the largest, and, at the present time, is supplying all the needs of the company, power houses 1 and 3 being held as auxiliaries.

Power House No. 1 is situated at Lower Bonnington Falls, about 18 miles from Nelson. The equipment includes three 1,100 volt 3-phase 60 cycle generators, with a combined capacity of 3,000 K.W. and twelve 250 K.W. 1,100/20,000 transformers.

Power House No. 2 is situated about half-mile above No. 1 and has an ultimate capacity of 32,000 H.P. at present, it contains two 5,625 K.W., 2,200-volt 3-phase, 60-cycle generators, one 12,000 K.W. and one 3,700 K.W. 2,200/22,000-volt transformers. There are 84 miles of double transmission lines, carrying 60,000 volts and 50 miles of double line carrying 20,000 volts.

Power House No. 3 is situated at Cascade. It contains three generators, 750 K.W. each, and nine 250 K.W., 2,200/22,000 volt transformers. Twenty-five miles of duplicate transmission lines to Grand Forks, Phœnix, Greenwood and Boundary Falls are so connected that power can be supplied from Bonnington Falls at 60,000, or from the Cascade system at 20,000 volts.

There are sub-stations at Trail, Rossland, Grand Forks, Phœnix and Greenwood.

Columbia River Basin

The Columbia river has a total length of 1,150 miles, of which 465 miles are in Canada. It drains, in Canada, an area of 39,300 square miles. It rises in Upper Columbia lake in the great "Inter-montane" valley between the Rockies and the Selkirks. From the lake, it flows northward to latitude 52°, turns westward at the "Big bend" to flow round the north end of the Selkirks, then flows southward through the valley between the Gold range and the Selkirks. Above Golden, it is a sluggish, navigable stream and, therefore, not available as a source of power. The tributaries that fall in from the east are small mountain torrents of little value from a power standpoint. The Dutch, Toby, Salmon and Spillimacheen are important tributaries with a large low-water discharge from the glaciers and snow-fields of the Selkirks. The Beaver, a western tributary and the Kicking Horse, an eastern branch, carry a large volume of water, but owing to the construction of the Canadian Pacific along their banks, economic development on a large scale might be difficult. The Blaeberry is an important stream and falls nearly 2,000 feet between its source in the Howse pass and the Columbia. Wood river and other tributaries of Canoe river, are glacier-fed torrents and, doubtless, contain many valuable powers; similarly with Goldstream, Downie, Carnes, Incomappleux, Illecillewaet and other streams that fall in below the "Big bend," although the same remark applies to the last named as to the Beaver.

The Kootenay has a total length of 400 miles, drains an area of 15,500 square miles and rises in the Rocky mountains about 20 miles south-east of Leanchoil station on the Canadian Pacific. As, in the upper portion of its course, it flows in a great valley parallel to the upper Columbia, then crosses the ranges to get into the "Inter-montane" valley and then, follows this valley, it is probable that most of the large powers must be looked for where it crosses the ranges. The Simpson, Cross, Palliser, White, Bull,

St. Mary, Elk and other tributaries of the Kootenay, are large streams with heavy falls and rapids.

The Kootenay follows the "Inter-montane" valley southward into Montana, turns westward and then, northward into Canada, to empty itself into Kootenay lake, thence westward to its confluence with the Columbia. Between Kootenay lake and the Columbia, it falls 350 feet in 25 miles, affording many valuable powers. The Slocan, Lardo, Duncan and other tributaries of the lower Kootenay are large streams with considerable fall.

The Pend d'Oreille river falls into the Columbia near the International boundary. With the exception of about 12 miles near its mouth and the upper portion of the Flathead tributary, it lies wholly within the United States. It has a total drainage area of about 30,000 square miles. It has been gauged by the United States Reclamation Service just below the mouth of Priest river; the minimum flow recorded was 5,419 cubic feet per second, on February 3, 1905, the next lowest, 7,852 cubic feet per sec., was taken on Jan. 19, of the same year. There are two power sites on this stream, near Waneta, B.C., which can be developed under heads of 75 and 50 feet, respectively, giving an estimated capacity of 65,000 and 45,000 H.P., respectively.

The Kettle and the Similkameen and their tributaries are also, affluents of the Columbia. While they contain numerous water-power sites, the summer flow is considerably less than that of the glacier-fed streams.

Fraser River Basin

The Fraser river is 695 miles long and receives the drainage of an area of 91,700 square miles. Of its principal tributaries, the Thompson drains 21,800 square miles and is 270 miles long; the Chilcotin, 7,500 square miles and is 145 miles long; the Blackwater, 5,600 square miles and is 140 miles long; the Nechaco, 15,700 square miles and is 255 miles long; the Stuart is 220 miles long, the North Thompson, 185 miles and the South Thompson, 120 miles.

The Fraser rises near the summit of the Yellowhead pass at an altitude of 3,710 feet. In 52 miles it falls to 2,400 feet near Tete Jaune Cache; thence, flows northwest in the "Inter-montane" valley to latitude 54°; then, like the Columbia at the "Big bend," it turns westward and southward. At Fort George, near its most northerly point, it is at an altitude of 1,900 feet—a descent of 500 feet in about 200 miles. Steamers have ascended it to Tete Jaune Cache, a circumstance which indicates a swift-flowing stream without considerable fall at any one point. The Grand Trunk Pacific grade on its banks would probably debar extensive damming except below the mouth of Bear river. During the season of navigation, steamers ply between Fort George and Soda Creek, which would, for the present, prevent the utilization of power sites on this stretch —such as Cottonwood cañon. The construction of the Vancouver branch

of the Grand Trunk Pacific railway down this river, however, will, probably, result in the abandonment of this steamship line. Below Chimney creek, the river enters the Fraser cañon to emerge near Hope. Between Fort George and Lillooet, about 255 miles, it falls 1,240 feet. Allowing a fall of, say, 3½ feet per mile for the 150 miles between Fort George and Chimney creek, there is left a descent of nearly 740 feet in the 105 miles between the latter and Lillooet. Between Lillooet and Lytton bridge, it falls 244 feet in 40 miles, and between the bridge and Hope, it falls 300 feet in 60 miles, having an altitude at Hope of about 115 feet above sea.

Below Lytton, irrespective of the difficulty—if not impossibility—of harnessing this raging torrent, the presence of the Canadian Pacific and Canadian Northern lines debars any attempt to generate power in this portion of its course. Above Lytton, as indicated above, there is even a greater fall per mile than below; but here, again, the construction of the Vancouver branch of the Grand Trunk Pacific may make it impossible to utilize this stretch—irrespective of the difficulties connected with the handling of the flow of a great river that has, in places, a range of 50 feet between high water and low water.

The Thompson is the largest affluent of the Fraser. It is 270 miles long—to the head of the North Thompson—and drains an area of 21,800 square miles. The foregoing remarks respecting the Fraser River cañon apply in large measure to the cañon of the Thompson above its confluence with the Fraser. The North Thompson—main branch—is 155 miles long and rises near Tete Jaune Cache, at an altitude of about 2,400 feet. Forty miles below, at the head of the cañon it is at elevation 2,066, a descent of 336 feet—eight feet per mile. At the "stillwater" below the cañon it is 1,925 feet, a fall of 141 feet in four miles. At its confluence with the South Thompson, near Kamloops, it is at altitude 1,133, a descent of 1,267 feet in the 170 miles from the head-waters. The Raft, Mad, Blue and Clearwater tributaries are important streams with steep descents.

The South Thompson is 120 miles long. It is navigable from Kamloops to Shuswap lake and contains no water-powers. Its upward continuation, the Shuswap, falls 130 feet between Enderby and Mabel lake. It drains Mabel lake, a reservoir 20 miles long and from half a mile to a wide. Adams river carries the discharge of Adams lake, a magnificent sheet of water, 37 miles long and one and a half miles wide. Between Adams lake and the South Thompson, the river descends 220 feet in five miles. The proposed installation on this stream will utilize a head of 165 feet.

The North Arm and Stave River powers have been described in connection with actual developments and further reference to them is unnecessary. In the Chilliwak, one of the southern tributaries of the Fraser, a development to utilize a head of 1,000 feet has been proposed. The

Coquihalla flows into the Fraser near Hope. It falls 3,400 feet in the 33½ miles between Summit lake and Hope. The Lillooet river drains a large area in the Coast range, a region of excessive rainfall. Between Lillooet and Harrison lakes, it falls 590 feet in about 30 miles. Its eastern branch, the Birkenhead, falls 890 feet in the first 16 miles above its confluence with the Lillooet. Green river, another tributary, descends nearly 1,400 feet in the 18 miles from Green lake to Pemberton meadows.

Cayoosh creek empties into the Fraser opposite Lillooet village. Between Anderson and Seton lakes, it falls 58 feet in four miles and between Seton lake and the Fraser, there is a descent of 134 feet in seven miles. Bridge river is a considerable tributary and drains a portion of the Coast range to the north of Cayoosh creek. By driving a tunnel from the valley of the latter, a head of 1,500 feet could be obtained.

The Chilcotin river drains an area of 7,500 square miles and is 145 miles long. Between Puntzee lake in its upper waters, and the mouth, it falls 1,750 feet. Its south branch, the Chilko, falls about 2,400 feet between Chilko lake and the Fraser. As Chilko lake is about 50 miles long and from four to five miles wide, there is excellent storage available.

The Quesnel river drains the southern portion of the Cariboo mountains. Between Quesnel lake and the mouth it falls 350 feet. Between Cariboo lake and the Fraser, its north branch falls 650 feet. Quesnel lake, 60 miles long and three miles wide, would provide excellent storage.

The Blackwater river drains an area of 5,600 square miles and 140 miles long. It falls about 1,700 feet between Tsacha lake—an expansion—and the Fraser.

The Nechaco drains an area of 15,700 square miles and is 255 miles long. Between Ootsabunkut lake and the Fraser, it falls 860 feet, of which 82 feet is in the short stretch between Ootsabunkut and Natalkuz lakes. Its north branch, the Stuart, is 220 miles long. The Nechaco basin contains a number of large lakes, including Ootsabunkut, 40 miles long, Cheslatta, 25, Français, 60 and Fraser, 12 miles; also Stuart lake with an area of 221 square miles and Tacla, 135 square miles.

On the North fork of the Fraser, about 35 miles from its confluence with the main stream, there is a fall 80 feet high.

Vancouver Island

The rivers of Vancouver island are short and steep. Except at the southeastern extremity of the island, where there is a comparatively small rainfall, there is a very heavy precipitation, especially on the west slope of the mountains. Near Victoria, however, storage is necessary in the summer. There are a number of lakes in the interior of the island that could be utilized for storage. Cowichan lake is 18 miles long, Sproat lake, 10, Central lake, 20, Buttle lake, 15 and Nimpkish lake, 12.

Mainland, Pacific Coast

Between the Skeena and the Fraser, no stream cuts across the Coast range. Consequently, in this area, all the rivers are short and steep but, on account of the very heavy precipitation on the west slope of the Coast range, they carry a heavy flow of water.

The Squamish empties into Howe sound. It is 34 miles long and between Green lake and its mouth, a distance of 33 miles, falls 2,070 feet. Eight hundred feet of this fall occurs between Daisy lake and the mouth of the Minatch, a distance of nine miles, and 450 feet between the former and the "forks" of the Tcharkamisht.

Powell river is a short stream and carries the discharge of Powell lake, twenty miles long and four miles wide. The lake forms an excellent reservoir and a head of 140 feet is obtainable with the power plant on tidewater.

The Homathko river rises in the Coast range at an altitude of 3,530 feet and is 92 miles long. Between Waddington cañon, 29th mile from tidewater, and Murderers bar, 32nd mile, it falls 350 feet; between the junction with the West branch, 37th mile, and head of Great canon, 40th mile, it falls 470 feet.

The Bellacoola river also rises in the Coast range and is about 60 miles long. Between the mouth of Driver river and Bentinck North arm, it falls 1,100 feet.

Dean river (also called Salmon river) rises in the Coast range near the headwaters of the Blackwater and Nechaco. Between the confluence with the Iltasyouco and the mouth, 45 miles, it falls 2,321 feet in 46¼ miles; between "Salmon House," at the 24th mile, and the "3rd crossing," quarter of a mile below, it descends 181 feet.

The Kemano river empties into Gardner inlet. Between Siffleur lake and tidewater, 18 miles, it falls 3,753 feet. Between the 9th and 12th miles from the mouth it descends 1,035 feet; of this descent, 214 feet occur in 1,000 feet horizontal.

Other rivers, south of the Skeena, that are known to contain valuable powers but for which no details are available, are: the Southgate, falling into Bute inlet; the Klinaklini, into Bute inlet; the Owikano, into Rivers inlet; the Kitlope, into Gardner canal; and the Kitimat into Douglas channel.

The Skeena river drains an area of 19,300 square miles and is 335 miles long. Between Hazelton and its mouth it has a fall of 725 feet but the construction of the Grand Trunk Pacific will probably prevent damming it to raise the water to any considerable height. The Babine river, a tributary, drains Babine lake, which has an area of 306 sq. miles. Between the lake and Kitkargas village, a distance of about 40 miles, it falls 1,000 feet.

Other important streams are: the Nass draining 7,400 square miles and 205 miles long; the Stikine, with a drainage basin 20,300 square miles in area, and 335 miles long and the Taku, draining 7,600 square miles.

The Peace river drains the northeastern portion of British Columbia. Between the junction of the Finlay and Parsnip—where it takes the name "Peace"—and the eastern boundary of the Province, there are no water-powers. Its south branch, the Parsnip is 145 miles long. Below the confluence of McLeod river, there are no rapids in the Parsnip. Above the McLeod, it is unsurveyed except the rough survey made by Mackenzie, in 1793. Some of its eastern tributaries, such as the Misinchinca, are torrential streams carrying a good flow of water. The Nation river, another tributary, is unexplored.

The north branch of the Peace—the Finlay—is 250 miles long. It ranges in width from 90 feet, where it issues from the Fishing lakes, to 900 feet near its mouth. Its navigation, for two hundred miles above its mouth, with the exception of Deserter cañon, is easy. Deserter cañon is situated about 90 miles above the mouth; is about half a mile long and, in the narrowest places, scarcely exceeds a hundred feet in width. The walls at the lower end are high. Where the Finlay flows through the Long cañon, above its confluence with the Tochieca, it is a succession of cañons, riffles and rapids, for many miles. The Long cañon is five miles long. The river, in places, is narrowed to less than 100 feet inwidth and contains numerous wild rapids. The total depth of the gorge, at the upper end exceeds 600 feet.

The Omineca, or south branch of the Finlay, is by far the largest tributary of the latter. The Black cañon, five miles from its mouth, is about half a mile in length and varies in width from one hundred to two hundred feet. Its walls are usually vertical and, in places, exceed 150 feet in height. Six miles above the mouth of the Oslinca, the Omineca flows through the Little cañon. Between the mouth and quiet water nine miles above Little cañon, the river falls 425 feet in a distance of 35 miles, an exceptionally high grade for a river of this size.

The following is a list of the principal known water-powers in these districts:

DISTRICT No. I—COLUMBIA RIVER AND TRIBUTARIES

Power Site	Minimum		Horse-Power Developed				REMARKS
	Head, in feet	Horse-Power	Electrical Energy	Mining	Other Industries	Total	
915. Pend d'Oreille river	75	65,000	.....	.....	.....	.....	
915. " " "	50	45,000	.....	.....	.....	.....	Waneta, B. C.
Kettle river:							
916. Boundary creek (tributary)	135	200	200	.....	.....	200	
917. Kettle river, Cascade plant	156	6,000	3,000	.....	.....	3,000	Operated as a reserve
918. Kettle river, Granby plant, Grand Forks	45	650	.....	650	.....	650	
919. Twenty-mile creek (tributary of Similkameen river)	412	.....	.....	750	.....	750	Proposed municipal plant
920. Penticton and Ellis creeks (tributaries of Okanagan)	.....	1,000	.....	.....	.....	.....	Proposed municipal plant
Kootenay river:							
921. Lower Bonnington falls, West Kootenay Power and Light Co	60	32,000	4,000	.....	.....	4,000	
922. Upper Bonnington falls, West Kootenay Power Co	60	32,000	15,000	.....	.....	15,000	
922. Upper Bonnington falls, Nelson municipal plant	40	5,000	2,650	.....	.....	2,650	
923. Slocan river (tributary)	20	2,000	.....	.....	.....	.....	
924. Granite creek (tributary)	20	65	.....	.....	.....	.....	
925. Cottonwood creek (tributary)	265	500	.....	.....	.....	.....	
926. Carpenter creek (tributary)	.....	.....	35	.....	.....	35	
926. South fork of Carpenter creek	.....	.....	.....	350	.....	350	
931. Bull river (tributary)	276	30,000					12,600 H. P. development under construction
932. St. Mary river (tributary)	60	5,700	.....	.....	.....	.....	
Kaslo creek:							
927. Kaslo creek, McGuigan	750	.....	.....	.....	.....	.....	
927. Kaslo creek, Whitewater	560	.....	.....	100	.....	100	
927. Kaslo creek, "	.....	.....	.....	175	.....	175	
928. Kaslo creek, Kaslo	650	.....	.....	100	.....	100	2,500 H.P. available in same watershed
928. " " "	41	.....	.....	150	.....	150	
929. Creek (un-named), Arrowhead (tributary of Columbia river)	450	.....	150	.....	.....	150	
930. Illecillewaet river (tributary of Columbia river)	73	.....	.....	.....	2,000	2,000	Municipal plant, near Revelstoke

BRITISH COLUMBIA

DISTRICT No. II—FRASER RIVER AND TRIBUTARIES

Power Site	Minimum		Horse-Power Developed				Remarks
	Head, in feet	Horse-Power	Electrical Energy	Mining	Other Industries	Total	
933. North arm, Burrard inlet	400	52,000	.....	.....	.....	.....	B.C. Electric Ry. Co.: water diverted from the Coquitlam river; 16 miles from Vancouver.
934. Stave river, Upper fall	100	28,000					Western Canada Power Co.; under construction; flow 3,000 cub. ft. per sec. "under usual operating conditions a peak load of 44,000 to 48,000 H.P. can be provided for."
934. Stave river, Lower fall	100	50,000					
935. Nicoamen river	280	4,000	33,260	.....	.....	33,260	Undeveloped
936. Chilliwak river	.....	50,000†	20,000	.....	.....	20,000	
936a. Chehalis river	.....	50,000†	.....	.....	.....	.....	
936b. Green river	.....	25,000†	.....	.....	.....	.....	Undeveloped
937. Lillooet lake	320	50,000†	.....	.....	.....	.....	
938. Hunter creek	350	4,500	.....	.....	.....	.....	
938. Coquihalla river	70	8,000	.....	.....	.....	.....	
938. Silver creek	80	7,000	.....	.....	.....	.....	
939. Emory creek	30	500	.....	.....	.....	.....	
940. Yale creek	40	500	.....	.....	.....	.....	
941. Siwash creek	500	4,000	.....	.....	.....	.....	
942. Spuzzum creek	80	3,500	.....	.....	.....	.....	
943. Anderson river	100	5,000	.....	.....	.....	.....	
944. Salmon river	70	15,000	.....	.....	.....	.....	
945. Quoieek creek	200	10,000	.....	.....	.....	.....	
946. Bridge river	1,500	.....	.....	.....	.....	.....	
947. Thompson river	200	100,000	.....	.....	.....	.....	Rapids between Lytton and Thompson; total fall
947a. Adams river (tributary of South Thompson)	165	37,400	.....	.....	.....	.....	With storage, minimum, 2,000 cub. ft. per sec.; present low water flow, 1,000 c.f.s.; primary development, 65 ft. head

† These estimates of water-power are based on the utilization of the available storage in the different drainage basins and are only approximate (H. M. Burwell, C. E., Aug. 10, 1910.)

948. Barrier river (tributary of the North Thompson)	80	2,000	.....	.....	.....	.....	.....
949. Raft river (tributary of the North Thompson)	100	1,000	.....	.....	.....	.....	.....
950. Mad river (tributary of the North Thompson)	100	500	.....	.....	.....	.....	.....
951. Clearwater river (tributary of the N. Thompson)	40	5,000	.....	.....	.....	.....	.....
952. Davis creek, near Barkerville, Cariboo	500	150	.....	.....	.....	.....	.....
953. Nazko river	50	100	.....	.....	.....	.....	.....

BRITISH COLUMBIA

DISTRICT No. III—VANCOUVER ISLAND

Power Site	Minimum		Horse-Power Developed				Remarks
	Head, in feet	Horse-Power	Electrical Energy	Mining	Other Industries	Total	
954. Sooke river	.....	1,000	.....	.....	.....	.....	
955. Jordan river	1,150	24,000	5,350	.....	.....	5,350	B. C. Electric Ry. Co.
956. Gordon river	350	8,000	.....	.....	.....	.....	
957. Nitinat river	50	*a*900	.....	.....	.....	.....	
958. Tsusiat river	80	*a*150	.....	.....	.....	.....	
959. Sarita river	240	*a*1,000	.....	.....	.....	.....	
960. Franklin creek	30	*a*130	.....	.....	.....	.....	
961. Stamp falls	75	6,000	.....	.....	.....	.....	
961. Sproat falls	50	5,000	.....	.....	.....	.....	
962. Somass falls	11	2,000	.....	.....	.....	.....	
963. Goldstream river	650	.....	4,000	.....	.....	4,000	
964. Millstream river	129	.....	500	.....	.....	500	Nanaimo Electric Light Co.
965. Puntledge river	90	9,000	.....	.....	.....	.....	Proposed development for mining purposes

a Figures approximate, 1 cubic foot per second per square mile being allowed for run-off.

BRITISH COLUMBIA

DISTRICT No. IV—MAINLAND, PACIFIC COAST

Power Site	Minimum		Horse-Power Developed				Remarks
	Head, in feet	Horse-Power	Electrical Energy	Mining	Other Industries	Total	
966. Powell river	140	100,000†					26,000 H.P. development under construction
966a Clowhom river	130	25,000†					
966b Cheakamus river	560	50,000†					
967. Link river	110	19,500			8,500	8,500	
968. Khtada river	300	15,000					Proposed 8,000 H.P. development for Prince Rupert
969. Union creek							Proposed development of 15,000 H.P.

†These estimates of water-power are based on the utilization of the available storage in the different drainage basins and are only approximate (H. M. Burwell, C. E., Aug. 10, 1910)

DISTRICT No. V—NORTHERN AND NORTH-EASTERN WATERSHEDS

970. Peace river, rapids between Custs House and Hudsons Hope	270						

APPENDICES

APPENDIX I

TREATY BETWEEN THE UNITED KINGDOM AND THE UNITED STATES OF AMERICA RELATING TO BOUNDARY WATERS AND QUESTIONS ARISING ALONG THE BOUNDARY BETWEEN CANADA AND THE UNITED STATES

Signed at Washington, January 11, 1909. *Ratifications exchanged at Washington, May* 5, 1910.

HIS Majesty the King of the United Kingdom of Great Britain and Ireland and of the British Dominions beyond the Seas, Emperor of India, and the United States of America, being equally desirous to prevent disputes regarding the use of boundary waters and to settle all questions which are now pending between the United States and the Dominion of Canada involving the rights, obligations, or interests of either in relation to the other or to the inhabitants of the other, along their common frontier, and to make provision for the adjustment and settlement of all such questions as may hereafter arise, have resolved to conclude a Treaty in furtherance of these ends, and for that purpose have appointed as their respective plenipotentiaries:

His Britannic Majesty, the Right Honourable James Bryce, O.M., his Ambassador Extraordinary and Plenipotentiary at Washington; and

The President of the United States of America, Elihu Root, Secretary of State of the United States;

Who, after having communicated to one another their full powers, found in good and due form, have agreed upon the following articles:

Preliminary Article

For the purposes of this Treaty boundary waters are defined as the waters from main shore to main shore of the lakes and rivers and connecting waterways, or the portions thereof, along which the international boundary between the United States and the Dominion of Canada passes, including all bays, arms, and inlets thereof, but not including tributary waters which in their natural channels would flow into such lakes, rivers, and waterways, or waters flowing from such lakes, rivers, and waterways, or the waters of rivers flowing across the boundary.

ARTICLE 1

The High Contracting Parties agree that the navigation of all navigable boundary waters shall for ever continue free and open for the purposes of commerce to the inhabitants and to the ships, vessels, and boats of both countries equally, subject, however, to any laws and regulations of either country, within its own territory, not inconsistent with such privilege of free navigation, and applying equally and without discrimination to the inhabitants, ships, vessels, and boats of both countries.

It is further agreed that so long as this Treaty shall remain in force, this same right of navigation shall extend to the waters of Lake Michigan and to all canals connecting boundary waters, and now existing or which may hereafter be constructed on either side of the line. Either of the High Contracting Parties may adopt rules and regulations governing the use of such canals within its own territory, and may charge tolls for the use thereof, but all such rules and regulations and all tolls charged shall apply alike to the subjects or citizens of the High Contracting Parties and the ships, vessels, and boats of both of the High Contracting Parties, and they shall be placed on terms of equality in the use thereof.

ARTICLE 2

Each of the High Contracting Parties reserves to itself or to the several State Governments on the one side and the Dominion or Provincial Governments on the other, as the case may be, subject to any treaty provisions now existing with respect thereto, the exclusive jurisdiction and control over the use and diversion, whether temporary or permanent, of all waters on its own side of the line which in their natural channels would flow across the boundary or into boundary waters; but it is agreed that any interference with or diversion from their natural channel of such waters on either side of the boundary, resulting in any injury on the other side of the boundary, shall give rise to the same rights and entitle the injured parties to the same legal remedies as if such injury took place in the country where such diversion or interference occurs; but this provision shall not apply to cases already existing or to cases expressly covered by special agreement between the parties hereto.

It is understood, however, that neither of the High Contracting Parties intends by the foregoing provision to surrender any right which it may have to object to any interference with or diversions of waters on the other side of the boundary the effect of which would be productive of material injury to the navigation interests on its own side of the boundary

ARTICLE 3

It is agreed that, in addition to the uses, obstructions, and diversions heretofore permitted or hereafter provided for by special agreement between the Parties hereto, no further or other uses or obstructions or diversions, whether temporary or permanent, of boundary waters on either side of the line, affecting the natural level or flow of boundary waters on the other side of the line, shall be made except by authority of the United States or the Dominion of Canada within their respective jurisdictions and with the approval, as hereinafter provided, of a joint commission, to be known as the International Joint Commission.

The foregoing provisions are not intended to limit or interfere with the existing rights of the Government of the United States on the one side and the Government of the Dominion of Canada on the other, to undertake and carry on governmental works in boundary waters for the deepening of channels, the construction of breakwaters, the improvement of harbours, and other governmental works for the benefit of commerce and navigation, provided that such works are wholly on its own side of the line and do not materially affect the level or flow of the boundary waters on the other, nor are such provisions intended to interfere with the ordinary use of such waters for domestic and sanitary purposes.

ARTICLE 4

The High Contracting Parties agree that, except in cases provided for by special agreement between them, they will not permit the construction or maintenance on their respective sides of the boundary of any remedial or protective works or any dams or other obstructions in waters flowing from boundary waters or in waters at a lower level than the boundary in rivers flowing across the boundary, the effect of which is to raise the natural level of waters on the other side of the boundary unless the construction or maintenance thereof is approved by the aforesaid International Joint Commission.

It is further agreed that the waters herein defined as boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property on the other.

ARTICLE 5

The High Contracting Parties agree that it is expedient to limit the diversion of waters from the Niagara River so that the level of Lake Erie and the flow of the stream shall not be appreciably affected. It is the desire of both Parties to accomplish this object with the least possible

injury to investments which have already been made in the construction of power plants on the United States' side of the river under grants of authority from the State of New York, and on the Canadian side of the river under licences authorized by the Dominion of Canada and the Province of Ontario.

So long as this Treaty shall remain in force, no diversion of the waters of the Niagara River above the Falls from the natural course and stream thereof shall be permitted except for the purposes and to the extent hereinafter provided.

The United States may authorize and permit the diversion within the State of New York of the waters of said river above the Falls of Niagara, for power purposes, not exceeding in the aggregate a daily diversion at the rate of twenty thousand cubic feet of water per second.

The United Kingdom, by the Dominion of Canada, or the Province of Ontario, may authorize and permit the diversion within the Province of Ontario of the waters of said river above the Falls of Niagara, for power purposes, not exceeding in the aggregate a daily diversion at the rate of thirty-six thousand cubic feet of water per second.

The prohibitions of this article shall not apply to the diversion of water for sanitary or domestic purposes, or for the service of canals for the purposes of navigation.

ARTICLE 6

The High Contracting Parties agree that the St. Mary and Milk Rivers and their tributaries (in the State of Montana and the Provinces of Alberta and Saskatchewan) are to be treated as one stream for the purposes of irrigation and power, and the waters thereof shall be apportioned equally between the two countries, but in making such equal apportionment more than half may be taken from one river and less than half from the other by either country so as to afford a more beneficial use to each. It is further agreed that in the division of such waters during the irrigation season, between the 1st of April and 31st of October, inclusive, annually, the United States is entitled to a prior appropriation of 500 cubic feet per second of the waters of the Milk River, or so much of such amount as constitutes three-fourths of its natural flow, and that Canada is entitled to a prior appropriation of 500 cubic feet per second of the flow of St. Mary River, or so much of such amount as constitutes three-fourths of its natural flow.

The channel of the Milk River in Canada may be used at the convenience of the United States for the conveyance, while passing through Canadian territory, of waters diverted from the St. Mary River. The provisions of Article 2 of this Treaty shall apply to any injury resulting to property in Canada from the conveyance of such waters through the Milk River.

The measurement and apportionment of the water to be used by each country shall from time to time be made jointly by the properly-constituted reclamation officers of the United States and the properly-constituted irrigation officers of His Majesty under the direction of the International Joint Commission.

ARTICLE 7

The High Contracting Parties agree to establish and maintain an International Joint Commission of the United States and Canada composed of six commissioners, three on the part of the United States appointed by the President thereof, and three on the part of the United Kingdom appointed by His Majesty on the recommendation of the Governor in Council of the Dominion of Canada.

ARTICLE 8

This International Joint Commission shall have jurisdiction over and shall pass upon all cases involving the use or obstruction or diversion of the waters with respect to which under Articles 3 and 4 of this Treaty the approval of this Commission is required, and in passing upon such cases the Commission shall be governed by the following rules and principles which are adopted by the High Contracting Parties for this purpose:

The High Contracting Parties shall have, each on its own side of the boundary, equal and similar rights in the use of the waters herein before defined as boundary waters.

The following order of precedence shall be observed among the various uses enumerated hereinafter for these waters, and no use shall be permitted which tends materially to conflict with or restrain any other use which is given preference over it in this order of precedence:

(1) Uses for domestic and sanitary purposes;

(2) Uses for navigation, including the service of canals for the purposes of navigation;

(3) Uses for power and for irrigation purposes.

The foregoing provisions shall not apply to or disturb any existing uses of boundary waters on either side of the boundary.

The requirement for an equal division may in the discretion of the Commission be suspended in cases of temporary diversions along boundary waters at points where such equal division can not be made advantageously on account of local conditions, and where such diversion does not diminish elsewhere the amount available for use on the other side.

The Commission in its discretion may make its approval in any case conditional upon the construction of remedial or protective works to compensate so far as possible for the particular use or diversion proposed, and in such cases may require that suitable and adequate provision, approved by the Commission, be made for the protection and indemnity against injury of any interests on either side of the boundary.

In cases involving the elevation of the natural level of waters on either side of the line as a result of the construction or maintenance on the other side of remedial or protective works or dams or other obstructions in boundary waters or in waters flowing therefrom or in waters below the boundary in rivers flowing across the boundary, the Commission shall require, as a condition of its approval thereof, that suitable and adequate provision, approved by it, be made for the protection and indemnity of all interests on the other side of the line which may be injured thereby.

The majority of the Commissioners shall have power to render a decision. In case the Commission is evenly divided upon any question or matter presented to it for decision, separate reports shall be made by the Commissioners on each side to their own Government. The High Contracting Parties shall thereupon endeavour to agree upon an adjustment of the question or matter of difference, and if an agreement is reached between them, it shall be reduced to writing in the form of a protocol, and shall be communicated to the Commissioners, who shall take such further proceedings as may be necessary to carry out such agreement.

ARTICLE 9

The High Contracting Parties further agree that any other questions or matters of difference arising between them involving the rights, obligations, or interests of either in relation to the other or to the inhabitants of the other, along the common frontier between the United States and the Dominion of Canada, shall be referred from time to time to the International Joint Commission for examination and report, whenever either the Government of the United States or the Government of the Dominion of Canada shall request that such questions or matters of difference be so referred.

The International Joint Commission is authorized in each case so referred to examine into and report upon the facts and circumstances of the particular questions and matters referred, together with such conclusions and recommendations as may be appropriate, subject, however, to any restrictions or exceptions which may be imposed with respect thereto by the terms of the reference.

Such reports of the Commission shall not be regarded as decisions of the questions or matters so submitted either on the facts or the law, and shall in no way have the character of an arbitral award.

The Commission shall make a joint report to both Governments in all cases in which all or a majority of the Commissioners agree, and in case of disagreement the minority may make a joint report to both Governments, or separate reports to their respective Governments.

In case the Commission is evenly divided upon any question or matter

referred to it for report, separate reports shall be made by the Commissioners on each side to their own Government.

ARTICLE 10

Any questions or matters of difference arising between the High Contracting Parties involving the rights, obligations, or interests of the United States or of the Dominion of Canada either in relation to each other or to their respective inhabitants, may be referred for decision to the International Joint Commission by the consent of the two Parties, it being understood that on the part of the United States any such action will be by and with the advice and consent of the Senate, and on the part of His Majesty's Government with the consent of the Governor General in Council. In each case so referred, the said Commission is authorized to examine into and report upon the facts and circumstances of the particular questions and matters referred, together with such conclusions and recommendations as may be appropriate, subject, however, to any restrictions or exceptions which may be imposed with respect thereto by the terms of the reference.

A majority of the said Commission shall have power to render a decision or finding upon any of the questions or matters so referred.

If the said Commission is equally divided or otherwise unable to render a decision or finding as to any questions or matters so referred, it shall be the duty of the Commissioners to make a joint report to both Governments, or separate reports to their respective Governments, showing the different conclusions arrived at with regard to the matters or questions so referred, which questions or matters shall thereupon be referred for decision by the High Contracting Parties to an umpire chosen in accordance with the procedure prescribed in the fourth, fifth, and sixth paragraphs of Article XLV of The Hague Convention for the pacific settlement of international disputes, dated October 18, 1907. Such umpire shall have power to render a final decision with respect to those matters and questions so referred on which the Commission failed to agree.

ARTICLE 11

A duplicate original of all decisions rendered and joint reports made by the Commission shall be transmitted to and filed with the Secretary of State of the United States and the Governor General of the Dominion of Canada, and to them shall be addressed all communications of the Commission.

ARTICLE 12

The International Joint Commission shall meet and organize at Washington promptly after the members thereof are appointed, and

when organized the Commission may fix such times and places for its meetings as may be necessary, subject at all times to special call or direction by the two Governments. Each Commissioner, upon the first joint meeting of the Commission after his appointment, shall, before proceeding with the work of the Commission, make and subscribe a solemn declaration in writing that he will faithfully and impartially perform the duties imposed upon him under this Treaty, and such declaration shall be entered on the records of the proceedings of the Commission.

The United States and Canadian sections of the Commission may each appoint a secretary, and these shall act as joint secretaries of the Commission at its joint sessions, and the Commission may employ engineers and clerical assistants from time to time as it may deem advisable. The salaries and personal expenses of the Commission and of the secretaries shall be paid by their respective Governments, and all reasonable and necessary joint expenses of the Commission, incurred by it, shall be paid in equal moieties by the High Contracting Parties.

The Commission shall have power to administer oaths to witnesses, and to take evidence on oath whenever deemed necessary in any proceeding, or inquiry, or matter within its jurisdiction under this Treaty, and all parties interested therein shall be given convenient opportunity to be heard, and the High Contracting Parties agree to adopt such legislation as may be appropriate and necessary to give the Commission the powers above mentioned on each side of the boundary, and to provide for the issue of subpœnas and for compelling the attendance of witnesses in proceedings before the Commission. The Commission may adopt such rules of procedure as shall be in accordance with justice and equity, and may make such examination in person and through agents or employees as may be deemed advisable.

Article 13

In all cases where special agreements between the High Contracting Parties hereto are referred to in the foregoing articles, such agreements are understood and intended to include not only direct agreements between the High Contracting Parties, but also any mutual arrangement between the United States and the Dominion of Canada expressed by concurrent or reciprocal legislation on the part of Congress and the Parliament of the Dominion.

Article 14

The present Treaty shall be ratified by His Britannic Majesty and by the President of the United States of America, by and with the advice and consent of the Senate thereof. The ratifications shall be exchanged at

Washington as soon as possible, and the Treaty shall take effect on the date of the exchange of its ratifications. It shall remain in force for five years, dating from the day of exchange of ratifications, and thereafter until terminated by twelve months' written notice given by either High Contracting Party to the other.

In faith whereof the respective plenipotentiaries have signed this Treaty in duplicate and have hereunto affixed their seals.

Done at Washington the 11th day of January, in the year of our Lord one thousand nine hundred and nine.

(L.S.) JAMES BRYCE.
(L.S.) ELIHU ROOT.

PROTOCOL OF EXCHANGE*

On proceeding to the exchange of the ratifications of the treaty signed at Washington on January 11, 1909, between Great Britain and the United States, relating to boundary waters and questions arising along the boundary between the United States and the Dominion of Canada, the undersigned plenipotentiaries, duly authorized thereto by their respective Governments, hereby declare that nothing in this treaty shall be construed as affecting, or changing, any existing territorial, or riparian rights in the water, or rights of the owners of lands under water, on either side of the international boundary at the rapids of the St. Mary's River at Sault Ste. Marie, in the use of the waters flowing over such lands, subject to the requirements of navigation in boundary waters and of navigation canals, and without prejudice to the existing right of the United States and Canada, each to use the waters of the St. Mary's River, within its own territory; and further, that nothing in this treaty shall be construed to interfere with the drainage of wet, swamp, and overflowed lands into streams flowing into boundary waters, and also that this declaration shall be deemed to have equal force and effect as the treaty itself and to form an integral part thereof.

The exchange of ratifications then took place in the usual form.

In witness whereof, they have signed the present Protocol of Exchange and have affixed their seals thereto.

Done at Washington this 5th day of May, one thousand nine hundred and ten.

(L.S.) JAMES BRYCE.
(L.S.) PHILANDER C. KNOX.

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*The British Ratification of this further Instrument was deposited with the United States Government on July 23, 1910.

APPENDIX II

AN ACT FOR THE PROTECTION OF THE PUBLIC INTERESTS IN THE BED OF NAVIGABLE WATERS

I GEORGE V, CHAP. 6 (ONTARIO)

Assented to

HIS Majesty, by and with the consent of the Legislative Assembly of the Province of Ontario, enacts as follows:—

1. This Act may be cited as "The Bed of Navigable Waters Act."

2. Where land bordering on a navigable body of water or stream has been heretofore, or shall hereafter, be granted by the Crown, it shall be presumed, in the absence of an express grant of it, that the bed of such body of water or stream was not intended to pass to the grantee of the land, and the grant shall be construed accordingly and not in accordance with the rules of the English Common Law.

3. Section 2 shall not affect the rights, if any, of a grantee from the Crown or of any person claiming under him, where such rights have heretofore been determined by a court of competent jurisdiction in accordance with the rules of the English Common Law, or of a grantee from the Crown, or any person claiming under him who establishes to the satisfaction of the Lieutenant-Governor that he or any person under whom he claims has previous to the passing of this Act developed a water power or powers under the *bona fide* belief that he had the legal right to do so, provided that he may be required by the Lieutenant-Governor in Council to develop the said power or powers to the fullest possible extent, and provided that the price charged for power derived from such water power or powers may from time to time be fixed by the Lieutenant-Governor in Council. And the Lieutenant-Governor in Council may direct that letters patent granting such right be issued to such grantee or person claiming under him, under and subject to such conditions and provisions as may be deemed proper for insuring the full development of such water power or powers, and the regulation of the price to be charged for power derived from them.

4. This Act shall not apply to the bed of the river where it runs through Lot 8 in the 6th Concession of the Township of Merritt, in the District of Sudbury.

5. Notwithstanding anything herein contained the case of any person setting up on special grounds a claim to receive from the Crown a grant or lease of any part of the bed of a navigable body of water or stream shall be dealt with by the Lieutenant-Governor in Council as he may deem fair and just.

6. This Act shall not come into force until a day to be named by the Lieutenant-Governor by his proclamation.

APPENDIX III

AN ACT TO REGULATE THE EXPORTATION OF ELECTRIC POWER AND CERTAIN LIQUIDS AND GASES

6–7 EDWARD VII, CHAP. 16, (CANADA)

(*Assented to 27th April*, 1907)

HIS Majesty, by and with the advice and consent of the Senate and House of Commons of Canada, enacts as follows:—

1. This Act may be cited as *The Electricity and Fluid Exportation Act.*

2. In this Act, unless the context, otherwise requires,—

(*a*) "export" and "exportation," when used with reference to electrical power of energy, mean respectively export and exportation from Canada by lines of wire or other conductor, and when used with reference to petroleum, natural gas, water or other fluid, whether liquid or gaseous, capable of being exported, mean respectively export and exportation from Canada through pipe lines or other like contrivances;

(*b*) "power" means electrical power or energy produced in Canada;

(*c*) "fluid" means petroleum, natural gas, water or other fluid, whether liquid or gaseous, capable of being exported by means of pipe lines or other like contrivances, and produced in Canada.

3. No person shall export any power or fluid without a license, or any power or fluid in excess of the quantity permitted by his license, or otherwise than as permitted by such license; Provided that any person who, immediately prior to the passing of this Act, is lawfully engaged in the exportation of power or fluid shall not, with respect to such exportation, be subject to the provisions of this Act until six months after this Act comes into force or until he has sooner obtained a license under this Act, unless and except in so far as his exportation at any time during the interval ratably exceeds in quantity of power or fluid the amount which he was exporting prior to the passing of this Act.

(2) No person shall, without a license, construct or place in position any line of wire or other conductor for the exportation of power, or any pipe line or other like contrivance for the exportation of fluid.

4. Subject to any regulations of the Governor in Council in that behalf, the Governor in Council may grant licenses, upon such conditions as he thinks proper, for the exportation of power or fluid where a right to export exists by lawful authority; and such license shall be revocable upon such notice to the licensee as the Governor in Council deems reasonable in each case.

5. Any such license may provide that the quantity of power or fluid to be exported shall be limited to the surplus, after the licensee has supplied for distribution to customers for use in Canada power or fluid to the extent defined by such license, at prices and in accordance with conditions, rules and regulations prescribed by the Governor in Council.

(2) Every such license shall be revocable at will by the Governor in Council if the licensee refuses or neglects to comply with any of the conditions imposed with regard to the supply and distribution of power or fluid in Canada.

6. Subject to any regulations of the Governor in Council in that behalf, the Governor in Council may grant licenses for the construction placing or laying of any line of wire or other conductor for the exportation of power, or of any pipe line or other like contrivance for the exportation of fluid.

7. Every person who exports any such power or fluid contrary to the provisions of this Act shall, for each day on which any such export takes place, be liable to a penalty not exceeding five thousand dollars and not less than one thousand dollars.

8. Every person who, contrary to the provisions of this Act, constructs, places or lays in position any line of wire or other conductor for the exportation of power, or any pipe line or other like contrivance for the exportation of fluid, shall for each such offence be liable to a penalty not exceeding five thousand dollars and not less than one thousand dollars, and to forfeiture and confiscation of such line of wire or other conductor, or of such pipe line or other contrivance, which may forthwith upon such conviction be destroyed or removed by direction of the Governor in Council.

9. The Governor in Council may make regulations not inconsistent with this Act for giving effect to the object and intention thereof, and by such regulations may impose fees to be paid thereunder by applicants for licenses or others.

(2) Such regulations shall be laid before Parliament within fifteen days after the making thereof, or, if Parliament is not then in session, within fifteen days after the opening of the next session thereof.

10. The Governor in Council may, by proclamation published in *The Canada Gazette*, impose export duties, not exceeding ten dollars per annum per horse power, upon power exported from Canada, or not exceeding ten cents per thousand cubic feet on fluid exported from Canada, and such duties shall be chargeable accordingly after the publication of such proclamation.

(2) The Governor in Council may, by proclamation published in like manner, from time to time remove or re-impose such duties or vary the amount thereof.

(3) The Governor in Council may, by proclamation published in like manner, exempt from the payment of such duties such persons as comply with the direction of the Governor in Council with regard to the quantity of power or fluid to be supplied by such persons for distribution to customers for use in Canada.

APPENDIX IV

REGULATIONS OF 4TH NOVEMBER, 1907, UNDER THE ELECTRICITY AND FLUID EXPORTATION ACT

THESE Regulations are to be construed as subject in all respects to the provisions of the Act and the several words, terms and expressions which by the Act meanings are assigned shall have therein the same to respective meanings:—

(*a*) "Minister" means the Minister of Inland Revenue;

(*b*) "Department" means the Department of Inland Revenue;

(*c*) "Contractor" means any person or Company undertaking to generate or produce electrical energy, gas or fluid for exportation from Canada;

(*d*) "Purchaser" means any person or Company to whom electrical energy, gas or fluid is furnished by the Contractor;

(*e*) The expression "Unit of Supply of Electrical Energy" means one Kilowatt hour, i. e., 1000 watts passing for one hour;

(*f*) The expression "Electrical Horse-Power Year" means the passing of 746 Watts of electrical energy for one year.

2. Before commencing to supply any electrical energy, gas or fluid for exportation, the contractor shall obtain from the Department a license in respect of such exportation, the application for which license shall contain full and exact information as to the quantities proposed to be exported from Canada.

3. The contractor, shall, on or before the 1st day of April of each year, make application for the license referred to in the previous paragraph and shall pay therefor the following fee, namely:—

(*a*) In the case of an electrical plant generating not more than 10,000 horse-power, twenty-five dollars;

(*b*) In the case of an electrical plant generating over 10.000 horse-power, fifty dollars;

(*c*) In the case of a natural gas plant, fifty dollars.

4. Any license issued hereunder shall be revocable at will by the Governor in Council if the licensee refuses or neglects to comply with any of the conditions from time to time imposed by the Governor in Council with regard to the supply and distribution of electrical energy, gas or fluid in Canada, and moreover, whenever such electrical energy, gas or fluid is required for the use of purchasers in Canada any such license shall be revocable upon such notice to the licensee as the Governor in Council deems reasonable in each case.

5. Monthly reports shall be made to the Department by the contractor containing full particulars as to the output of the generating plants

or wells of production, showing separately the total number of units generated for export and for consumption in Canada.

6. For the measurement of electrical energy integrating watt-meters of approved design shall be installed in such a manner as to show the total number of units generated for export and for consumption in Canada respectively.

7. Before commencing to construct, subsequent to the issuance of the license, transmission lines of wire for the exportation of electrical energy, or lines of pipe for the exportation of gas or fluid, the contractor shall obtain from the Department a license for such construction.

The contractor shall furnish a drawing or map showing the proposed location of the transmission lines or any extension thereof; also:—

(*a*) The gauge of the wire conductors for the transmission of electrical energy;

(*b*) The diameter in inches of the pipe lines for gas or fluids, and

(*c*) The number of conductors or pipe lines that it is proposed to build or construct.

8. Where a supply of electrical energy, gas or fluid is provided in any part of Canada by the contractor for export and home consumption then the price charged to any person or company in Canada by the contractor shall not exceed the prices at which electrical energy, gas or fluid is sold by the contractor for export in like quantities under similar circumstances.

9. Any officer authorized by the Minister for the purposes of the Act may at all reasonable times, and not less frequently than once in every year, enter any premises in which electrical energy, gas or fluid is generated or produced in order:—

(*a*) To inspect the generating plant, to test any wires, pipes meters or other measuring devices through which electrical energy, gas or fluid may be supplied to any purchaser, or

(*b*) To inspect the contractor's books for the purpose of ascertaining the quantities and prices of the commodities sold and such other information as may be deemed necessary for the proper administration of the Act, and

(*c*) To inspect all contracts entered into between the contractor and the purchaser for a supply of electrical energy, gas or fluid.

10. The accuracy of any meter or other measuring device through which electrical energy, gas or fluid may be sold, either for export or home consumption, shall be determined by the Department in accordance with the provisions of the Electricity and Gas Inspection Acts, Chapters 14 (1907) and 87 R. S. (1906) respectively and the regulations made thereunder.

APPENDIX V

FORM OF LICENSE TO EXPORT POWER, DOMINION OF CANADA

INLAND REVENUE DEPARTMENT

License to Export Electrical Energy Under the Provisions of the Electricity and Fluid Exportation Act, 6–7 Edward VII, Chap. 16, and the Regulations Made Thereunder

LICENSE No. *is hereby granted to the* *doing business at* *in the County of* *and Province of* *to export or to sell for export from Canada during the fiscal year ending* 31*st of March* 19 , *electrical energy at a rate not to exceed* *kilowatt years.*

This license is subject to the provisions of the Regulations, in reference to the governance of electrical power, &c., approved by the Governor General in Council on the 4th day of November, 1907; *which Regulations are made conditions hereof.*

Deputy Minister of Inland Revenue.

Countersigned

Chief Electrical Engineer.

Dated at Ottawa this
day of 19

BIBLIOGRAPHY

BOOKS, REPORTS AND PAMPHLETS CONTAINING DATA RELATING TO THE WATER-POWERS OF THE DOMINION OF CANADA

(*Compiled by Arthur V. White*)

"Knowledge is of two kinds. We know a subject ourselves, or we know where we can find information upon it. When we enquire into any subject, the first thing we have to do is to know what books have treated of it."—Samuel Johnson.

THE following list of books, reports and pamphlets enumerates the publications which contain data relating to the water-powers of the province of Ontario. The list is not complete; but it contains the representative publications, and may be regarded as a safe guide to the literature which relates, both directly and indirectly, to Ontario's water-powers.

On account of the great importance which attaches to the water-power possibilities of the international waterways constituting the southerly boundary of the province of Ontario, there have been included in the following list the more important recent reports made by some of the commissions upon waterways appointed by the United States government. Thus, reference is made to Reports by the Deep Waterways Commission, the Inland Waterways Commission, the National Waterways Commission, and the International Waterways Commission.

On account of the water-powers situated upon interprovincial waters, it is concluded advisable to include in the list here given some reports which deal with issues relating to portions of Ontario's provincial boundaries. And again, owing to the increasing commercial values of water-powers connected with Government canals, it has been considered profitable to make mention of some of the chief reports relating to Canadian canals.

Some reports, as, for example, those by E. B. Borron, have been listed because, generally speaking, but little clue can be found even to the existence of some of them.

Some of the smaller pamphlets enumerated in the list derive their importance from the fact that they occupy prominent places in the history of the development of the hydro-electric policy of the Ontario Government.

For convenience of reference the publications have been broadly grouped under certain subject headings. It must be understood, however, that the contents of the various reports are by no means restricted to the particular subjects under which classification has been made. The subject headings are as follow:

1. Works of Reference containing data which Relate to the Waters of the Province of Ontario.
2. Reports, etc., by the Hydro-Electric Power Commission of the Province of Ontario.

3. Miscellaneous Reports, etc., having relation to Hydro-Electric Power matters.
4. List of Reports made to the Ontario Government by E. B. Borron (Stipendiary Magistrate).
5. Reports relating to the Niagara River and Falls.
6. Reports by Dawson, Russell, and Hind *re* the country between Lake Superior and Lake Winnipeg.
7. Reports relating to the St. Lawrence River, St. Mary River, Rainy River, etc.
8. Some Reports relating to Canadian Canals.
9. Reports (chiefly by the United States Government) relating to Waterways.
10. Reports by the International Waterways Commission.
11. Some Reports relating to the Northerly and Westerly Boundaries of the Province of Ontario.
12. Reports relating to the Water-Powers of the Province of Quebec.
13. Pamphlets, etc., relating to Legislation as affecting Waters; and to Municipal Operation, etc., of Public Utilities.
14. Annual Reports of the Union of Canadian Municipalities.

Works of Reference Relating to the Water-Powers of Ontario

(1)

ATLAS OF CANADA. (White) Department of the Interior; Canada, Ottawa, 1906. 21 pp. and 83 maps and plates. Folio. Map No. 33 gives drainage basins and the lengths of rivers.

ALTITUDES IN THE DOMINION OF CANADA, by James White, Geological Survey of Canada (Pub. No. 745). Ottawa, 1901. xii + 266 pp. with map, also maps in separate folder, 8°.

DICTIONARY OF ALTITUDES IN THE DOMINION OF CANADA, with a relief map of Canada, by James White, Department of the Interior; Ottawa, 1903. x + 143 pp.; 8°.

METEOROLOGICAL SERVICE. *Rain- and Snow-Fall of Canada to the end of* 1902, with charts of annual precipitation, by Hugh V. Payne; Ottawa, 1906. viii + 188 pp. 4°, with charts. (A new edition is in course of preparation.)

GEOLOGICAL SURVEY OF CANADA. For Annual Reports and special publications, consult *Catalogue of Publications of the Geological Survey of Canada* (Revised to January 1, 1909). Pub. No. 1073. Ottawa, 1909. 181 pp., 8°.
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Opinions given by the Commission on Power Projects in 1910, pp. 113-117.
Draft Bill of Dominion Public Health Conference *re* Pollution of Waterways, p. 167

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by

E. B. BORRON

(*Stipendiary Magistrate*)

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INDEX TO OFFICIAL DOCUMENTS. Compiled by the office of the Park Superintendent, John H. Jackson, and published by the Queen Victoria Niagara Falls Park Commission. (*Printed privately; not for distribution*). Reproduced below by courtesy of the Park Commission.

INTERNATIONAL WATERWAYS COMMISSION REPORTS. See below under this heading.

HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO, REPORTS. See above under this heading. See also under heading "Miscellaneous Reports, etc., relating to Hydro-Electric Power matters," above given.

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Appendix A.—Report of Hon. T. E. Burton, Chairman of the Committee on Rivers and Harbours, on House Joint Resolution 83, calling for reports from International Waterways Commission. Pp.251-252.

Appendix B.—Report of Senator Frank B. Brandegee, Chairman of the Committee on Forest Reservations and the Protection of Game, on House Joint Resolution 83. Pp.253-260.

Appendix C.—(S. Doc. 242.) Message from the President of the United States, transmitting the report of the American members of the International Waterways Commission, with letters from the Secretary of State and Secretary of War, including memoranda regarding the preservation of Niagara Falls. Pp.-261-282.

Appendix D.—(S. Doc. 434.)—Message from the President of the United States, transmitting a report made to the Secretary of War by the International Waterways Commission, under date of May 3, 1906, upon the preservation of Niagara Falls. Pp.-283-285.

Appendix E.—Report of Hon. T. E. Burton on H.R. 18024 for preservation of Niagara Falls. Pp.-286-290.

Appendix F.—W. J. Clark, manager traction department General Electric Company, Statement of industrial value of Niagara Falls. Pp.- 291-297.

Appendix G.—Henry E. Gregory, counsel for the American Scenic and Historical Association, brief of law on navigable and boundary streams. Pp.-298-307.

Appendix H.—Report of Lieut.-Col. W. H. Bixby, Corps of Engineers, U. S. Army, showing effect of withdrawal of water from Lake Michigan by the sanitary district of Chicago. Pp.-308-323.

Appendix I.—An Act for the control and regulation of the waters of Niagara River, for the preservation of Niagara Falls, and for other purposes, approved June 29, 1906. Pp.-324-325.

Index to Official Documents Relating to Queen Victoria Niagara Falls Park

YEAR	TITLE	DATE
1880	Act respecting Niagara Falls and adjacent territory	5th March, 1880
1885	Act for preservation of Natural Scenery about Niagara Falls	30th March, 1885
	Report of Commissioners *re* land selected	18th Sept., 1885
	Report of Commissioners *re* change in boundary	7th Dec., 1885
	Order in Council approving selection of lands	14th Dec., 1885
1886	Report of Commissioners	16th March, 1886
	Act respecting awards under Park Act	25th March, 1886
	First Annual Report of Commissioners	5th March, 1887
1887	Park Act	23rd April, 1887
	Second Annual Report of Commissioners	21st Feby., 1888
	Report of Park Superintendent	31st Dec., 1887
1888	Act authorizing acquisition of Toll Road	23rd March, 1888
	Order in Council approving of Park By-laws	26th April, 1888
	Order in Council approving of appointment of James Wilson, Superintendent; and of James Quillinan, Accountant	2nd Nov., 1887
	Grant of Chain Reserve, Clifton House to Queenston	26th April, 1888
	Order in Council, Change in By-laws	20th Nov., 1888
	Third Annual Report of Commissioners	5th Feby., 1889
	Report of Park Superintendent	31st Dec., 1888
	Order in Council approving of Chain Reserve being vested in Commissioners	26th April, 1888
1889	Lease of Waterworks privileges to Town of Niagara Falls	1st Sept., 1889
	Fourth Annual Report of Commissioners	10th March, 1889
	Report of Park Superintendent	31st Dec., 1889
1890	Certified Report of the Privy Council *re* Grant of lands to Commissioners, in Stamford and Niagara Townships	4th Nov., 1890
	Grant by Dominion Government of lands in Stamford and Niagara Townships	4th Nov., 1890
	Fifth Annual Report of Commissioners	16th March, 1891
	Report of Park Superintendent	31st Dec., 1890
1891	Grant of Chain Reserve, Townships of Willoughby, Bertie and Niagara	5th Nov., 1891
	Sixth Annual Report of Commissioners	25th March, 1892
	Report of Park Superintendent	Feby., 1892
	Order in Council approving of lands in Bertie, Willoughby and Niagara being vested in Commissioners	17th Oct., 1891
	Specifications of work to be done for Electric Railway	4th Dec., 1891
1892	Memo. by Commissioner of Public Works approving plans and specifications for Electric Railway	8th April, 1892
	Act to confirm Agreement with Canadian Niagara Power Company, 7th April, 1892	14th April, 1892
	Act to incorporate the Niagara Falls Park and River Railway with Agreement of the 4th December, 1891	14th April, 1892
	Order in Council *re* Tolls in Park	25th June, 1892
	Seventh Annual Report of Commissioners	27th April, 1893
	Report of Park Superintendent	Jany., 1893
1893	Report of Superintendent on Chain Reserve along the Niagara River from Fort Erie to Niagara	28th July, 1893
	Eighth Annual Report of Commissioners	17th March, 1894
	Lease of Photographic and other privileges in the Park to Zybach & Brundage	6th June, 1893
	Report of Park Superintendent	24th Feby., 1894
1894	Order in Council vesting foreshore in Commissioners	6th July, 1894
	Order in Council authorizing issue of Debentures, $60,000	14th, May, 1894
	Order in Council authorizing further issue of Debentures for $15,000	7th Nov., 1894
	Ninth Annual Report of Commisioners	2nd March, 1895
	Agreement for double tracking Electric Railway, with memo. of works to be performed	27th March, 1894
	Chippawa Extension Agreement with the Niagara Falls Park and River Railway Company	7th May, 1894

YEAR	TITLE	DATE
1894	Agreement with Clifton Suspension Bridge Company	11th April, 1894
	Agreement with Niagara Falls Suspension Bridge Company	3rd May, 1894
	Report of Park Superintendent	20th Feby., 1895
1895	Order in Council vesting Brock's Monument in Park Commissioners	19th March, 1895
	Lease of Ordnance Lands at Queenston	17th Dec., 1895
	Grants to Province, lands at Queenston Heights	5th May, 1896
	Agreement with Town of Niagara Falls *re* River Road	25th Nov., 1895
	Agreement with Town of Niagara Falls *re* Waterworks	9th Dec., 1895
	Map of Park System	Feby., 1896
	Tenth Annual Report of Commissioners	2nd March, 1896
	Report of Park Superintendent on lands included in Park System	28th July, 1893
	Report by Park Superintendent on Brock's Monument Grounds	12th Sept., 1894
	Annual Report of Park Superintendent	1st Feby., 1896
	Map of the Niagara River showing Park Lands	1st Feby., 1896
1896	Act authorizing Grant of lands to Clifton Suspension Bridge Company	7th April, 1896
	Agreement with Town of Niagara Falls *re* sewerage system	22nd May, 1896
	Order in Council appointing Messrs. B. E. Charlton and James Bampfield, Commissioners	23rd Sept., 1896
	Eleventh Annual Report of Commissioners	9th March, 1897
	Report by Superintendent on Military Reserve at Fort Erie	25th Aug., 1896
	Report by Superintendent on Military Reserve at Niagara-on-the-Lake	26th Aug., 1896
	Report by Superintendent on Military Reserve at Queenston Heights	25th Aug., 1896
	Report of Park Superintendent	1st Feby., 1897
1897	Agreement with Electric Railway *re* Sidewalks	24th April, 1897
	Twelfth Annual Report of Commissioners	12th Jany., 1898
	Agreement with Canadian Niagara Power Company and Niagara Falls Park and River Railway *re* sale of surplus power	27th Nov., 1897
	Report by Superintendent on water powers on lower Niagara River, with map	20th June, 1897
	Report of Park Superintendent	31st Dec., 1897
	Map *re* the water powers of the Niagara River below the Falls	20th June, 1897
	Park Act as consolidated in Revised Statutes of Ontario, 1897	1897
1898	Thirteenth Annual Report of the Commissioners	Jany., 1899
	Report of the Park Superintendent	20th Jany., 1899
	Lease of wharf privileges to Marchment and Company	18th July, 1898
	Lease of wharf privileges to James Sheppard	22nd July, 1898
	Lease of wharf privileges to Maid of the Mist Steamboat Company	18th July, 1898
	Report by Superintendent on Chain Reserve, Upper Niagara River, with map	10th Oct., 1898
	Report by Superintendent on proposed Park at Fort Erie	10th Oct., 1898
	Order in Council approving Agreement of 27th November, 1897, between the Canadian Niagara Power Co., the Niagara Falls Park and River Railway, and the Commissioners of the Park	9th Dec., 1897
	Grant of Ordnance Reserve at Queenston	4th Aug., 1898
1899	Act authorizing surrender of Agreement, 1892, by Canadian Niagara Power Company; and	1st April, 1899
	Authorizing Commissioners to enter into Agreement for use of waters of Niagara or Welland River for power purposes	1st April 1899
	Fourteenth Annual Report of Commissioners	Jany., 1900
	Annual Report of Park Superintendent	31st Dec., 1899
	Agreement with Canadian Niagara Power Company	15th July, 1899
	Agreement with Fort Erie Ferry Railway company	10th April, 1900

YEAR	TITLE	DATE
1899	Agreement with Ontario Power Company	11th April, 1900
	Order in Council approving above Agreement	13th April, 1900
1900	Act confirming Agreement with Fort Erie Ferry Railway Company	30th April, 1900
	Fifteenth Annual Report of the Commissioners	Jany., 1901
	Report of the Park Superintendent	Jany., 1901
	Order in Council approving of Agreement with the Ontario Power Company of 11th April, 1900	13th April, 1900
1901	Act authorizing sale of Niagara Falls Park and River Railway to Buffalo Railway Company	15th April, 1901
	Sixteenth Annual Report of the Commissioners	Jany., 1902
	Report of the Park Superintendent	Jany., 1902
	Agreement with Canadian Niagara Power Company for extension of time	19th June, 1901
	Agreement with Canadian Niagara Power Company *re* shaft.	19th June, 1901
	Agreement with Ontario Power Company—Supplementary.	15th Aug., 1901
	Agreement with Ontario Power Company—Ancillary	15th Aug., 1901
	Order in Council approving of By-laws.	11th July, 1901
	Order in Council approving of appointment of Messrs. Willox, Whistler, McGuane, Shrimpton, as Provincial Constables for one year	26th July, 1901
1902	Order in Council approving of Supplementary and Ancillary Agreements with Ontario Power Company	23rd April, 1902
	Act confirming Agreement of 19th June, 1901, with Canadian Niagara Power Company	17th March, 1902
	Statutory amendment changing name of Buffalo Railway Company to International Railway Company	17th March, 1902
	Map showing location of power plants in the Park.	1st March, 1903
	Seventeenth Annual Report of the Commissioners	4th March, 1903
	Report of Park Superintendent	4th March, 1903
	Agreement with the Ontario Power Company, "Niagara River Intake"	28th June, 1902
	Agreement with Messrs. Mackenzie, Pellatt and Nicholls	29th Jany., 1903
	Memo. prepared by Chairman J. W. Langmuir *re* development of Electrical Power at Niagara Falls	25th Nov., 1902
	Memo. of the Commissioners submitted to the Government on the occasion of the hearing given the Canadian Niagara Power Company and the Ontario Power Company	19th Dec., 1902
	Arguments and briefs of the Solicitors and the opinions of the Engineers in *re* application of Messrs. Mackenzie, Pellatt and Nicholls:	
	(1) Petition of Applicants' Counsel	17th Dec., 1902
	(2) Argument submitted by Applicants' Counsel for proposed site	Dec., 1902
	(3) Argument of Hugh L. Cooper, Applicants' Engineer	23rd Dec., 1902
	(4) Opinion of J. J. R. Croes, Consulting Engineer.	22nd Dec., 1902
	(5) Rejoinder of Hugh L. Cooper to arguments of Canadian Niagara Power Company's Engineer.	Dec., 1902
	(6) Letter of Canadian Niagara Power Company's Counsel	29th Dec., 1902
	(7) Opinion of Canadian Niagara Power Company's Engineer	Dec., 1902
	(8) Memo. presented by Canadian Niagara Power Company's Counsel	29th Dec., 1902
	(9) Rejoinder of Canadian Niagara Power Company's Engineers to arguments of Applicants	3rd Jany., 1903
	(10) Arguments and opinions submitted by International Railway Company's Counsel	5th Jany., 1903
	(11) Opinion of International Railway Company's Engineers	2nd Jany., 1903
	(12) Reply of Hugh L. Cooper to Railway Company's Engineers	7th Jany., 1903

YEAR	TITLE	DATE
1902	(13) Park Superintendent's letter submitting arguments of Expert Engineers	7th Jany., 1903
	(14) Report of Isham Randolph, Consulting Engineer.	12th Jany., 1903
	(15) Report of Robert C. Douglas, Consulting Engineer	20th Jany., 1903
	(16) Concluding Report of Park Commissioners to Government	1903
	Report by Isham Randolph, C.E., upon sites available for power plants	4th April, 1903
	Report by L. L. & P. N. Nunn, on transmission of electric power	27th April, 1903
	Order in Council approving of Ancillary Agreement	15th Aug., 1902
	Order in Council approving of Supplementary Agreement	7th Aug., 1902
	Order in Council approving of Ontario Power Company's Coffer Dam	20th Aug., 1902
	Agreement amending Supplementary and Ancillary Agreements with the Ontario Power Company	28th June, 1902
	Order in Council approving of negotiations with Messrs. Mackenzie, Pellatt and Nicholls	23rd Jany., 1903
	Order in Council approving of the head works of the Ontario Power Company	23rd Dec., 1902
	Order in Council approving of Robert Jaffray's appointment as Commissioner	8th Oct., 1902
1903	Order in Council approving of Agreement entered into with Messrs. Mackenzie, Pellatt and Nicholls	30th Jany., 1903
	Order in Council abrogating Tolls on Islands	24th March, 1903
	Order in Council approving of Agreements with Ontario Power Company of the 28th February and 14th February, 1903, with memo. dated 27th February, 1903	6th March, 1903
	Statutory amendment to Act 62 Victoria (2), Chap. 11 (page 87)	12th June, 1903
	Statutory amendment to Act 2 Edward VII., Chapter 11 (page 161)	12th June, 1903
	Act authorizing improvement of bank of Upper Niagara River	12th June, 1903
	Eighteenth Annual Report of Commissioners	3rd Feby., 1904
	Order in Council authorizing Honorarium to Chairman J. W. Langmuir	6th March, 1903
	Report of the Park Superintendent	Jany., 1903
	Address of Chairman Langmuir to the American Park and Outdoor Art Association	8th July, 1903
	Agreement with the Ontario Power Company "Pipe Line and Power House Agreement"	28th Feby., 1903
	Order in Council approving of above Agreement	6th March, 1903
	Agreement with Messrs. Zybach & Brundage	14th Feby., 1903
	Agreement with Canadian Shipbuilding Company	30th Dec., 1903
1904	Statutory amendment to Agreement with the Canadian Niagara Power Company	26th April, 1904
	Statutory amendment to Park Act, 1887	26th April, 1904
	Nineteenth Annual Report of the Commissioners	1st March, 1905
	Report of the Park Superintendent	1st March, 1905
	Agreement with Electrical Development Company for proposed second franchise	9th Jany., 1905
1905	Act to confirm Agreement with Messrs. Mackenzie, Pellatt and Nicholls, dated 29th January, 1903, and assignment thereof to the Electrical Development Company	25th May, 1905
	Twentieth Annual Report of the Commissioners	20th Feby., 1906
	Report of the Park Superintendent	20th Feby., 1906
	Order in Council *re* appointment of Messrs. L. Clarke Raymond and Philip William Ellis, Commissioners	14th June, 1905
	Memo. respecting the application of the International Railway Company to generate and export electricity	4th Jany., 1906
	Report of the Superintendent on the proposed Dam at the outlet of Lake Erie	24th Aug., 1905

YEAR	TITLE	DATE
1905	Order in Council approving of Agreement with Electrical Development Co., 9th January, 1905	16th Jany., 1905
1906	Twenty-first Annual Report of the Commissioners	18th Feby., 1907
	Report of the Park Superintendent	18th Feby., 1907
	Map of the Queen Victoria Park System	Feby., 1907
1907	Act for the preservation of Butler's Burying Ground at Niagara-on-the-Lake	20th April, 1907
	Twenty-second Annual Report of the Commissioners	21st Feby., 1908
	Report of the Park Superintendent	21st Feby., 1908
	Address delivered by Chairman Langmuir before the American Civic Association in Providence, R.I., with map	19th Nov., 1907
	Agreement with Electrical Development Company for construction of conduit to Canadian Niagara Power house	30th Aug., 1907
	Order in Council appointing William L. Doran Commissioner	11th Oct., 1907
1908	An Act respecting further issue of debentures for $100,000, subject to those issued	14th April, 1908
	Order in Council approving of charges under the peak power system for power generated in excess of 10,000 horse-power	4th Feby., 1907
	Act confirming Agreement with Electrical Development Company, dated 30th August, 1907	14th April, 1908
	Act respecting the establishment of Queenston Heights Park	14th April, 1908
	Twenty-third Annual Report of the Commissioners	13th Feby., 1909
	Report of the Park Superintendent	13th Feby., 1909
	Contract for the construction of Section No. 1, Niagara River Boulevard	11th Aug., 1908
	Contract for the construction of Section No. 4, Niagara River Boulevard	19th Sept., 1908
	Contract for the construction of Frenchman's Creek Bridge	11th Aug., 1908
	Hearing at Niagara Falls before the Attorney-General and the Park Commissioners with reference to the system of measurement to be adopted by Power Companies in the Park	15th Feby., 1908
	Review by Isham Randolph, C.E., of Prof. Wm. Spencer's Physics of the Niagara River	13th April, 1908
	Agreement with Hydro-Electric Power Commission and Ontario Power Company confirmed	14th April, 1908
	Order in Council, appointment of Lionel H. Clarke as Commissioner	24th Nov., 1908
1909	Order in Council approving of appointment of John H. Jackson, O.L.S., as Superintendent	27th Jany., 1909
	Twenty-fourth Annual Report of the Commissioners	3rd March, 1910
	Report of the Superintendent	3rd March, 1910
	Agreement with City of Niagara Falls, Ontario, for the construction of 12-inch water main	26th March, 1910
	Agreement with the Ontario Power Company *re* Conduit No. 2, and Resolution of the Company	22nd Sept., 1909

Reports re the Country between Lake Superior and Lake Winnipeg

(6)

DAWSON, S. J.—Report on the Exploration of the Country between Lake Superior and the Red River Settlement, and between the Latter Place and the Assiniboine and Saskatchewan. Printed by order of the Legislative Assembly. Toronto, 1859. With maps; 45 pp., 4°. Contains, Profile of Route by the Grand Portage and Pigeon River from Lake Superior to Rainy Lake; also, Profile of Route between Lake Superior and Rainy Lake by the Kaministiquia and Rivière La Seine. (The profiles show the locations and lengths of the respective portages, and the heights of the various falls and rapids. Hor. scale, 4 miles to 1 inch; Vert. scale, 200 feet to 1 inch.) This Report is also printed in the *Journals of the Legislative Assembly of the Province of Canada;* Vol. 17, part of Appendix No. 36. 22 Vict., 1859.

Report on the Line of Route between Lake Superior and the Red River Settlement; with Appendix. Ottawa, 1868. With "Map showing Line of Route between Lake Superior and Red River Settlement;" Scale, 10 miles to 1 inch. For list of maps accompanying Dawson's Report, see *Ibid*, page 7. *Sessional Papers*, Canada, No. 81, 1868.

Report on the Line of Route between Lake Superior and the Red River Settlement, by S. J. Dawson, Esq., Civil Engineer. Ottawa, 1st May, 1869. *Sessional Papers*, Canada, No. 12, 1870; pp. 32–56. (On p. 34 will be found a list of the five maps which accompanied the Report.) Compare *Sess. Pap.*, Canada, No. 42, 1869.

RUSSELL, ALEX. J.—The Red River Country, Hudson's Bay & North-West Territories considered in relation to Canada, with the last Report of S. J. Dawson, C.E., on the Line of Route between Lake Superior and the Red River Settlement. Illustrated by a map. Ottawa, 1869. xv + 202 pp., 8°. 2nd Edition. (The 1st Edition is referred to as a Pamphlet which was destroyed by fire.)

The Red River Country, Hudson's Bay & North-west Territories considered in relation to Canada, with the last two Reports of S. J. Dawson, Esq., C.E., on the Line of Route between Lake Superior and the Red River Settlement accompanied by a map. Montreal, 1870. xv + 197 pp., 8°. 3rd Edition. Illustrated. (8 plates of illustrations.) Dawson's reports are given abridged; Report of 1868, pp. 161–170; Report of 1869, pp. 171–197.

HIND, HENRY YOULE.—Report on a Topographical and Geological Exploration of the Canoe Route between Fort William, Lake Superior and Fort Garry, Red River; and also of the Valley of Red River, north of the 49th parallel, during the summer of 1857. Toronto, 1858; 12 pp. Published in *Journals of the Legislative Assembly of the Province of Canada*, Vol. 16; Appendix No. 3, Session 1858.

Report of the Exploration of the Country between Lake Superior and the Red River Settlement. Toronto, 1858, with maps. 425 pp., 8°. The large plan is "Plan showing the proposed route from Lake Superior to Red River Settlement; compiled from Messrs. Dawson and Napier's Maps" (scale plotted.) This plan shows "Profile of Canoe Route as handed in by Professor Hind." On a portion of the plan is also printed, on a scale of 8 miles to 1 inch, a reduced copy of S. J. Dawson's "Plan of the Country between Red River Settlement and the Lake of the Woods," which accompanied his report of 15th March, 1858.

This report by Hind was also published as "Papers relating to the Exploration of the Country between Lake Superior and the Red River Settlement." (British Govt. Blue Book.) London, 1859. 163 pp. Some additional correspondence is here given, also four maps entitled:

(1) Plan showing the proposed Route from Lake Superior to Red River Settlement.
(2) Part of the Valley of Red River, north of the 49th parallel.
(3) Copy of Sketch of the Region Explored between Red River and the Great Saskatchewan.
(4) Copy of Sketch showing the Region Explored by S. J. Dawson and his party, between Red River and the Great Saskatchewan.

North West Territory: Reports of Progress; together with a preliminary and general report on the Assiniboine and Saskatchewan Exploring Expedition, made under instructions from the Provincial Secretary, Canada. Toronto, 1859. Illustrated, also maps and plates; xii + 201 pp., 4°. (Printed by order of the Legislative Assembly.) The above report is also published in the *Journals of the Legislative Assembly of the Province of Canada.* Vol. 17. Appendix No. 36, 22 Vict., 1859

Narrative of The Canadian Red River Exploring Expedition of 1857, and of the Assiniboine and Saskatchewan exploring expedition of 1858. 2 Vols. London, 1860. Illustrated, also maps and plans. Vol. i, xx + 494 pp.; Vol. ii, xvi + 472 pp., 8°. (See Vol. ii Appendix, p. 399, *et seq.* for "Table showing the lengths, distances from Lake Superior, heights, elevation above Lake Superior, and the number of Portages on the Kaministiquia Route.)

Reports Relating to the St. Lawrence River, St. Mary River, Rainy River, &c.*

(7)

MONTREAL HARBOUR COMMISSION. Official Documents and other Information relating to the Improvement of the Ship Channel between Montreal and Quebec. Montreal, 1884. xv + 352 pp., 8°. (Published by the Montreal Harbour Commissioners.) Pages 345–6 contain a bibliographical list of early reports.

INLAND NAVIGATION OF CANADA. Baillairgé, G. F. St. Lawrence Navigation, Rivers Ottawa, Saguenay and Lake St. John, also Navigable Waters, Manitoba and North West Territories, Port Nelson and Hudson's Bay, also Elevations of the St. Lawrence above mean sea level, and Water Levels, etc. Supplement to Minister of Public Works' Report for the fiscal year 1886–87. Ottawa, 1888. Appendix No. 29, Part 1. 64 pp., 8°. *Sess. Pap.* No. 7A, 1888.

MONTREAL FLOOD COMMISSION. Report of the Montreal Flood Commission, with Interim Reports, Tables, etc., 86 pp., 8°. Annual Reports of Minister of Public Works, for the fiscal year 1889–90. *Sess. Pap.* Part II., No. 9, 1891. (See Index to diagrams, charts, profiles, etc., pp. 83–96, consisting of 114 items.)

WATER LEVELS. Annual Report of the Minister of Public Works for the fiscal year 1890–91. Part II. "Water levels, River St. Lawrence between Quebec and Montreal." Contains abstracts of results of Geodetic Levelling, fluctuation of levels on the St. Lawrence River, etc. Ottawa, 1893. 419 pp., 8°. *Sess. Pap.* No. 8, 1892.

PROFILE OF ST. LAWRENCE. For profile of the St. Lawrence River, see mention of Plan No. 10 under "Deeper Waterways," given below. See, also, under Marine and Fisheries, Section 1, above.

DAWSON, SAMUEL EDWARD. The St. Lawrence Basin and its Border-Lands, being the story of their Discovery, Exploration and Occupation. Illustrations and maps. London, 1905. xl + 451 pp., 8°. (On pages 429–442 are enumerated 173 items being a "List of the chief works consulted or referred to in preparing this volume.")

HOLGATE, HENRY. The Upper St. Lawrence River; its International History, Development of Navigation, and Future Possibilities. Montreal, 1911, 12 pp. 8°. See Proceedings, Canadian Society of Civil Engineers.

U. S. ENGINEERS' REPORTS. Report of the Chief of Engineers: Annual Reports of the War Department. Washington, 1866— *In Progress.* See Analytical and Topical Index to Reports of Chief of Engineers and officers of Corps of Engineers, U.S. army, 1866-1900. Washington, 1902–3. Three volumes.

*At the date of publication of this *Report on the Water-Powers of Canada*, time did not permit the extending of the list of reports appertaining to the St. Mary, Rainy, and other International Boundary waters. A. V. W.

RAINY RIVER. Construction of dam across Rainy River. Text of bill and general debate in U.S. House of Representatives, May 23, 1908. *Congressional Record.* Vol. 42, No. 132; pp. 7167 to 7172.

NOTE.—The President vetoed the Rainy River (Minnesota and Canada) Dam bill, on the grounds that no limit of time was put on the grant and no payment to the Government for use of the water of a navigable stream was exacted. Because of representations subsequently made and pledges by the dam corporation, he consented that the bill extending the time for completing the dam should be passed over his veto, and it was passed, 240 to 5.

RAINY RIVER DAM. Speech of John S. Williams of Mississippi, in House of Representatives, May 23, 1908. *Congressional Record,* Vol. 42, No. 133, p. 7191.

Report favoring bill extending time for construction of dam across Rainy River. Ordered printed May 12, 1908. 4 pages. 60th Congress, 1st session, House report, No. 1767.

Report of sub-committee on dams and water-powers to Committee on Interstate and Foreign Commerce, 60th Congress, 2nd session, February 25, 1909. 44 pages.

NOTE.—This pamphlet, compiled and published by the sub-committee on dams and water-power of the House Committee on Interstate and Foreign Commerce, contains President Roosevelt's veto messages on the acts to permit the building of dams across Rainy River, Minn., and James River, Mo., and his letter to Representative Bede; also, the report of the sub-committee, the report of the commissioner of corporations on concentration of water-power control, questions submitted by the sub-committee to the Solicitor-General and his answers thereto, a report by the chief engineers, and other papers relating to water-powers and their conservation. See also, *Congressional Record,* Vol. 43, No. 65; pp. 3480 to 3494.

Veto message of the President of the United States relating to bill to extend time for construction of dam across Rainy River. Ordered printed Sept 17, 1908, 3 pages. 60th Congress, 1st sess., Senate document, No. 438.

NOTE.—In this message the President maintains the doctrine that all private use of power from navigable streams should be paid for and should be granted for limited periods only. See also *Congressional Record,* Vol. 42, No. 94, p. 4854.

ST. MARY RIVER. St. Marys Falls Canal (H.R. 19366). Hearings before the Committee on Rivers and Harbours of the House of Representatives of the United States. 60th Cong., 1st Sess. Washington, 1908. pp. 65 to 286, with maps, 8°.

ST. CLAIR RIVER (Michigan). Reports of Examination and Survey of Channel in St. Clair River, Mich., between Russell Island and Grand Point, 1908, 7 pages, 2 maps. 60th Cong. 1st sess. House doc. No. 453.

INTERNATIONAL WATERWAYS COMMISSION. See list of Reports under Section No. 10 below for Reports relating to St. Mary, St. Clair, Niagara, St. Lawrence, Rainy and other International rivers.

Some Reports Relating to Canadian Canals

(8)

FLEMING, PETER. St. Lawrence Canals and Gradual Diminution of the Discharge of the River St. Lawrence. Dundee, January 7th, 1849. 15 pp., 8°. (In book of "Railway Reports," 1850; Library of Canadian Society of Civil Engineers, Montreal.)

SHANLY, WALTER. Report on the Ottawa and French River Navigation Project; submitted to the Legislative Assembly of Canada, and printed by their order: July, 1858; 8°. Reprinted, Ottawa, 1900. 58 pp. (This report gives data upon falls and rapids upon French river, rivière de Vase, river Matawan, river Ottawa. For Summary see Appendix A, p. 55.)

CLARKE, T. C. Report of T. C. Clarke, Esq., on *The Montreal, Ottawa and Georgian Bay Navigation*, submitted to the Legislative Assembly in 1860; together with a Supplementary Report by Mr. Clarke on the Present Aspects of the Undertaking. With maps and profile. Reprinted, Ottawa, 1900. 63 pp., 8°. (This report gives data *re* elevations *en route*, etc.)

KINGSFORD, WILLIAM. The Canadian Canals: Their History and Cost, with an enquiry into the Policy necessary to Advance the Well-Being of the Province. Toronto, 1865. iv + 191 pp., 8°.

CANAL COMMISSION. Letter to the Honourable the Secretary of State from the Canal Commissioners respecting the Improvement of the Inland Navigation of the Dominion of Canada. With maps. Ottawa, 1871. 329 pp., 8°.

"Synopsis of Information" relating to the Canals of Canada. There are enumerated, under each canal, various early Plans and Reports appertaining to the respective canals. Appendix D. *Sess. Pap.* Canada, No. 54, 1871; pp. 154–6.

BENDER, E. P. Report of Survey of French River, Georgian Bay, Lake Huron. Made for the Department of Railways and Canals in 1878. Reprinted Ottawa, March, 1900. 7 pp., 8°.

JUDSON, WM. P. From the West and North West to the Sea by way of the Niagara Ship Canal—1890, with two maps, 24 pp., 8°.

KEEFER, THOS. C. The Canals of Canada. (Read before the Royal Society of Canada, 1903.) Montreal, 1894. 46 pp., with map and plates, small 4°.

GEORGIAN BAY SHIP CANAL. Report, etc., of the Special Committee of the Senate of Canada upon the feasibility and advantages of a waterway connecting Lake Huron with the St. Lawrence via the Ottawa River. The Montreal, Ottawa and Georgian Bay Canal. Appendix No. 4, 3rd Sess. 61 Victoria, 1898. Ottawa, 1898, 51 pp.,8°.

Interim Report, Georgian Bay Ship Canal: Brief description and detailed estimates of cost for proposed waterway. Ottawa, 1908. vii + 69 pp., with two maps and 24 plans. *Sess. Pap.*, Canada, No. 178b, 1908.

Georgian Bay Ship Canal, Report upon Survey, with Plans and Estimates of Cost. Department of Public Works, Canada. Ottawa, 1909; xii + 601 pp. Illustrated plates, maps; *Typical Views on the Projected Route* (24 folding plates of views). Three plate holding cases, containing in all 56 Plates showing Maps, survey plans, construction plans, etc., 8°., *Sess. Pap.*, Canada, No. 19a, 1909.

Georgian Bay Ship Canal Survey: Report on the Precise Levelling, years 1904 to 1907. Ottawa, 1908, with map. 157 pp., 8°. *Sess. Pap.*, Canada, No. 19a, 1908.

Reports Relating to Waterways*

(9)

BIBLIOGRAPHY.—

List of Books and Articles in Periodicals relating to Inter-ocean Canal and Railway Routes. By Hugh A. Morrison, Jr. With an Appendix: Bibliography of United States Public Documents. (Prepared in the office of the Superintendent of Documents.) Washington, 1900. 174 pp. 56th Cong., 1st Sess. Sen. doc. No. 59.

List of Works relating to Deep Waterways from the Great Lakes to the Atlantic Ocean. (Printed as Manuscript.) Library of Congress, Washington, 1908; 59 pp., 8°. This work contains, *Deep Waterways: Articles in Periodicals*, p. 32, *et seq.*; also, *United States Documents on Deep Waterways*, p. 44, *et seq.*

* Chiefly by the U. S. Government.

DEEP WATERWAYS.—

Proceedings of the Deep Waterways Convention, held at Toronto, September 17–20, 1894. (Published by order of the City Council of Toronto.) Toronto, 1894; 108 pp., 8°.

Proceedings of the First Annual Convention of the International Deep Waterways Association, Cleveland, September 24, 25, 26, 1895. With an Appendix; Including a Report of The Proceedings of the Toronto Convention, 1894. Prepared by Frank Abial Flower, Executive Secretary. Printed, Toronto, N.D. 464 pp., 8°.

Deep Waterways from the Great Lakes to the Atlantic. Reports of the Canadian members of the International Commission. Printed by order of Parliament; Ottawa, 1897. 62 pp. and folded map; 8°. *Sess. Pap.*, Canada, No. 16A, 1898. (See page 16 for list of eleven plans submitted with the report.)

Plan No. 10, which accompanied this report, although not published with it, was, however, separately published. The plan is entitled "Profile of the St. Lawrence River and Canals." Compiled from Official Records, by A. J. Grant. Hor. scale, 13,200 feet = 1 inch. Vert. scale, 50 feet = 1 inch. "The surface of the river is shown at its lowest known stage, which occurred in November, 1895."

Report of the Board of Engineers on Deep Waterways between the Great Lakes and the Atlantic Tide Waters. In two parts, with Atlas, Washington, 1900, 4°. Part 1, 1–571 pp.; Part II, 571–1115 pp. Atlas with 141 folding maps and diagrams. 56th Cong., 2nd Sess. House doc. No. 149.

Report of the United States Deep Waterways Commission, prepared at Detroit, Michigan, December 18–22, 1896, by the Commissioners James B. Angell, John E. Russell, Lyman E. Cooley, Washington, 1907. 263 pp., also 26 folding maps and diagrams. 54th Cong., 2nd Sess. House doc. No. 192.

ROYAL COMMISSION ON TRANSPORTATION. Report of the Royal Commission on Transportation. Appointed May 19, 1903. Ottawa, 1906. 63 pp., 8°. (Printed as Supplement to the Report of the Minister of Public Works, 1905.) *Sess. Pap.*, Canada, No. 19A, 1906.

INLAND WATERWAYS COMMISSION. Preliminary Report of the Inland Waterways Commission. Message from the President of the United States transmitting a Preliminary Report of the Inland Waterways Commission. Illustrated; Washington, 1908. vii + 701 pp., with maps in pocket, 8°. 60th Cong., 1st Sess., Sen. doc. No. 325.

COMMISSION OF CORPORATIONS. Report of the Commissioner of Corporations on Transportation in the United States. 2 vols. Washington, 1909. (Dept. of Labour and Commerce.) 8°.
Part I. General Conditions of Transportation by Water. xviii + 614 pp.
Part II. Water-Borne Traffic. xxiv + 402 pp.

Report of the Commissioner of Corporations on Transportation by Water in the United States. 3 Vols. Washington, 1909, 8°.
Part I. General Conditions of Transportation by Water. xviii + 614 pp.
Part II. Water-Borne Traffic. xxiv + 402 pp.
Part III. Water Terminals, xxi + 436 pp.

NATIONAL WATERWAYS COMMISSION. Preliminary Report of the United States National Waterways Commission, (January 24th, 1910), Washington, 1910. 71 pp., 8°. 61st Cong., 2nd Sess., Sen. doc. No. 301.

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DAMS AND WATER POWER. Report of Sub-committee on Dams and Water Power to the Committee on Interstate and Foreign Commerce, House of Representatives. Washington, 1909. 44 pp., 8°.

INTERNATIONAL WATERWAYS COMMISSION. See list given below under Section 10.

Reports by the International Waterways Commission

(10)

CANADIAN PUBLICATIONS

REPORTS OF THE INTERNATIONAL WATERWAYS COMMISSION, 1906. Printed as Vol. II of the Report of the Minister of Public Works, Canada, for 1906. Ottawa, 1907. viii + 293 pp. 8°. (*Sess. Papers* No. 19a, 1907); and "contains all reports issued by The International Waterways Commission to January 4th, 1909," as follows:

1. First Progress Report of the Canadian members of the International Waterways Commission, 1905. pp. 1–87

2. Interim Report of the American Section, Appendix A-1. pp. 89–95

3. Second Interim Report of the Canadian Section of the International Waterways Commission, Ottawa, April 25, 1906. pp. 97–102

4. Joint Report of the Commission on the conditions existing at Niagara Falls, with Recommendations. Buffalo, N.Y., May 3, 1906. pp. 103–4

5. Report on the Conditions existing at Sault Ste. Marie, with Rules for the control of the same, recommended by the International Waterways Commission. Buffalo, N.Y., May 3, 1906. pp. 105–114

6. Joint Report on the Application of the International Development Company for permission to construct regulating works on the Richelieu River. Buffalo, N.Y., November 15, 1906. pp. 115–117

7. Joint Report on the Application of the Minnesota Canal and Power Company, of Duluth, Minnesota, for permission to divert certain waters in the State of Minnesota from the boundary waters between the United States and Canada, 1906. Buffalo, N.Y., November 15, 1906. pp. 118–137

8. Third Report of the Canadian Section, 1906. Ottawa, January, 1907. pp. 139–172

9. Joint Report on the Chicago Drainage Canal, 1907. Toronto, January 4, 1907. pp. 173–229

10. Report of the International Waterways Commission on the location of the Boundary Line between the United States and Canada through Lake Erie. Toronto, January 4, 1907. pp. 230–234

11. American Section. Second Progress Report, December 1, 1906. pp. 235–242. (See *Note* on p. 242 *re* p. 97, *et seq.*)

12. Report of the American Section on the Preservation of Niagara Falls. Message from the President of the United States, transmitting the Report of the American Members of the International Waterways Commissions, with letter from the Secretary of War, including memoranda regarding the Preservation of Niagara Falls. pp. 243–293.

Regarding items 1 to 12. Some of the reports above specified were first issued in other forms, as pamphlets, etc.; thus, items 1, 2, 3 and 4 were issued as *International Waterways Commission*, Canada, Department of Public Works, Supplement to Report 1905. Ottawa, 1906. 104 pp., 8°; and also as *Reports of the International Waterways Commission, Canadian and American Sections*, 1905. *Sess. Papers*, No. 19B, Ottawa, 1906; 104 pp., 8°. Items 3 and 4 were issued as *Second Interim Report of the Canadian Section*

and First Joint Report of the International Waterways Commission. Ottawa, April 25, 1906. 16 pp., 8°. Item 5 was issued, under same title, as a pamphlet. Buffalo, 1906. 20 pp., 8°. Item 6 was issued as *Joint Report of the International Waterways Commission,* transmited, Buffalo, November 15, 1906. 7 pp., 8°. Item 7 was issued as *Report of the International Waterways Commission upon the Application, etc.,* as pamphlet, 40 pp., 8°. Item 9 is U. S. War Document No. 293; Wash., 1907. Item 10 was issued under same title as above as pamphlet, 11 pp., 8°. Item 11 is taken from Second Progress Report of U.S. Section of International Waterways Commission.

Supplementary Report to December 31, 1907. (*Sess. Papers* No. 19B, 1908.) Ottawa, 1908. 36 pp., 8°.

Supplementary Report of the International Waterways Commission, 1908. (*Sess. Papers* No. 19C, 1908.) Ottawa, 1908. 5 pp., 8°.

Supplementary Report of the International Waterways Commission, 1909. (*Sess. Papers* No. 19C, 1909.) Ottawa, 1909. 6 pp., 8°.

Report of the International Waterways Commission on The Regulation of Lake Erie, with a Discussion of The Regulation of The Great Lakes System, together with Appendix, tables and plates. Ottawa, 1910. 169 pp. and 29 plates, 8°.

INTERNATIONAL BOUNDARY WATERS TREATY. Report on Treaty Relating to Boundary Waters and Questions arising along the boundary between Canada and the United States. Ottawa, 1910. (Return) 86 pp., 8°. *Sess. Pap.,* Canada, No. 19E, 1910.

Articles of International Boundary Waters Treaty. Ottawa, 1910, 7 pp., 8°. *Sess. Pap.,* Canada, No. 104a, 1910.

(The Articles of the Treaty are published as Canada, *Sessional Papers,* No. 104a, 1910.)

UNITED STATES PUBLICATIONS

FIRST PROGRESS REPORT, December 1, 1905. Wash., 1905, 15 pp., 8°.

SECOND PROGRESS REPORT, December 1, 1906. Wash., 1906, 39 pp., 8°.

THIRD PROGRESS REPORT, December 1, 1907. Wash., 1907, 81 pp., 8°.

FOURTH PROGRESS REPORT, December 1, 1908. Wash., 1908, 18 pp., 8°.

FIFTH PROGRESS REPORT, December 1, 1909. Wash., 1909, 11 pp., 8°

SIXTH PROGRESS REPORT, November 1, 1910. Wash., 1910, 13 pp., 8°.

Some Reports Relating Chiefly to the Northerly and Westerly Boundaries of the Province of Ontario

(11)

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MILLS, DAVID. A Report on the Boundaries of the Province of Ontario. Toronto, 1873, with maps. vi + 418 pp., 8°.

RAMSAY, T. K. Report of T. K. Ramsay, Esq., K.C., on the Northern and Western Limits of Ontario. (Confidential). Ottawa (?), 1873, with maps. 38 pp., 8°. (See pp. 37–38 for list of books and papers quoted.)

REPORT ON THE BOUNDARIES. Report on the Boundaries of the Province of Ontario, containing in part the substance of a report prepared for the Government of the Province in 1872, by David Mills, Esq., M.P.; and afterwards revised and con-

siderably enlarged by the author for the purposes of the arbitration between the Dominion of Canada and the Province of Ontario. Toronto, 1877. v + 204 pp., 8°.

North-Western Ontario. North-Western Ontario: Its Boundaries, Resources and Communications. Toronto, 1879, with map. iv + 64 pp., 8°. (Prepared under instructions from the Ontario Government.) *Sess. Pap.*, Ontario, No. 22, 1879.

Statutes, Documents and Papers. Statutes, Documents and Papers bearing on the Discussion respecting the Northern and Western Boundaries of the Province of Ontario, including the principal evidence for and against the claims of the Province. Compiled by direction of the Government of Ontario; with explanatory notes. Toronto, 1879. viii + 449 pp., 8°. *Sess. Pap.*, Ontario, No. 31, 1879.

Report of the Select Committee. Report of the Select Committee on the Boundaries between the Province of Ontario and the unorganized Territories of the Dominion, with Appendix. (Printed by order of Parliament.) Ottawa, 1880, 8°, xxviii + 183 pp.; in all, with appendix, 480 pp.+ ii pp.

Hincks, Hon. Sir Francis. The Northerly and Westerly Boundaries of the Province of Ontario, and the award relating thereto, as discussed and explained by the Hon. Sir Francis Hincks, K.C.M.G. in his public lecture at the Education Department, Toronto, May 6th, 1881. Toronto, 1881. 32 pp., 8°.

Correspondence and Papers respecting the Disputed Territory on the Northerly and Westerly sides of Ontario. 52 pp. + 24 pp. *Sess. Pap.*, Ontario, No. 23, 1882.

Correspondence, Papers and Documents of Dates from 1856 to 1882, inclusive, relating to the Northerly and Westerly Boundaries of the Province of Ontario. Toronto, 1882, with map. xxvii + 504 pp. *Sess. Pap.*, Ontario, No. 69, 1882.

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Memorandum of Agreement between the Governments of the Provinces of Ontario and Manitoba in regard to the territory in dispute between them. 9 pp. *Sess. Pap.*, Ontario, No. 3, 1884.

Privy Council. In the matter of the Boundary between the Provinces of Ontario and Manitoba, in the Dominion of Canada.
Between the Province of Ontario, of the one part, and the Province of Manitoba, of the other part.

Joint Appendix of Documents. (Brief No. 1.) In the matter of the boundary between the Provinces of Ontario and Manitoba; in the Dominion of Canada. Between the Province of Ontario, of the one part and the Province of Manitoba, of the other part. Toronto, n.d., with maps. xiii + 721 pp., 4°.

Book of Arbitration Documents, mentioned in the Agreement between the Provinces of Ontario and Manitoba; and referred to in the *Special Case* as showing in part what materials were before the Arbitrators. Toronto, 1884, with maps. (The above consists of 480 pp.) Then follows:
Appendix of the Province of Ontario, 160 pp.
Supplement to Appendix of the Province of Ontario, 127 pp.
Memorandum on the part of Ontario, 16 pp.

Correspondence of Chief Justice Draper; Agent of the Province of Canada as to the Proceedings of the Committee of the House of Commons, appointed to consider the question of the Renewal of the Hudson's Bay Company's License of Exclusive Trade, 1857, and as to their rights and claims generally. Toronto, 1884, 18pp. Maps at the end of the volume.

The Proceedings Before the Judical Committee of Her Majesty's Imperial Privy Council on the *Special Case* respecting the Westerly boundary of Ontario, argued 15th, 16th, 17th, 19th, 21st and 22nd July, 1884, with notes of Explanation and Correction. Toronto, 1889, with map. 421 pp., 8°. *Sessional Papers*, Ontario, No. 60, 1889.

REPORT OF A SELECT COMMITTEE. Report of a Select Committee of the Legislative Assembly of the Province of Kewaydin, upon the Boundaries of the adjoining Province of Ontario. With an Appendix containing the evidence. Printed, before presentation, from a manuscript copy, without permission of the Legislature. Winnipegosis, 1884, with map. 54 pp., 8°.

MACDONELL, JOHN P. The Ontario Boundary Controversy: Legal and Constitutional —Political and Historical: The Proceedings before the Imperial Privy Council, with Selections from the Documents in Evidence. A special Appendix, and an elaborate illustrative historical map. Edited, with critical and explanatory notes by John P. Macdonell, of the Ontario Civil Service. Toronto, 1896. 421 pp., 8°.

BOUNDARIES OF ONTARIO (Memo). Data not here listed will be found indicated under "Boundaries" in the General Indexes to the *Journals* and *Sessional Papers* of the Dominion of Canada, and of the Province of Ontario.

Some Reports Relating to the Water-Powers of the Province of Quebec

(12)

Information relating to the Ottawa river and its tributaries, as well as to other matters of interest appertaining to the waters of the province of Ontario, will be found in the following Reports, which deal with the water-powers of the province of Quebec:

REPORTS OF THE COMMISSIONER OF LANDS, FORESTS AND FISHERIES for 1898, 1900 and 1901.

REPORTS OF THE MINISTER OF LANDS, MINES AND FISHERIES for 1902, 1903, 1904 and 1905.

REPORTS OF THE MINISTER OF LANDS AND FORESTS for 1906, 1907 and 1908.

RETURN No. 69 of the Legislative Assembly of Quebec gives a "List of Water-powers sold or leased by the Province from 1st July, 1867, to 1st January, 1907." Quebec, 1907, 32 pp., 8°.

ROUILLARD, EUGENE. The White Coal: The Water-Powers of the Province of Quebec. Quebec, 1909. 41 pp., 8°.

Pamphlets, &c., Relating to Legislation as Affecting Waters, and to Municipal Operations of Public Utilities

(13)

DISALLOWANCE. A Question of Disallowance: Argument before the Privy Council, on the Petitions for the Vetoing of the Power Legislation of Ontario: Dated Ottawa, October 7th, 1909. 79 pp., 8°. *Printed privately.*

The Answer of the Government of Ontario to the Applications for Disallowance of the Power Legislation of the Session of 1909. This is "The Report of the Attorney General for Ontario, adopted by Order in Council dated 7th December, 1909, and transmitted by His Honour The Lieutenant-Governor for Ontario to the Government of Canada. Printed by the Ontario Government. Toronto, N.D., 24 pp., small 8°.

The Federal Decision on the Disallowance applications is discussed in the daily papers published in Toronto 23rd April, *et seq*, 1910. Consult, when published, the next item, "Provincial Legislation."

PROVINCIAL LEGISLATION. Correspondence, Reports of the Ministers of Justice and Orders in Council upon the subject of Dominion and Provincial Legislation; 1867–1895 (Compiled under the Direction of the Honourable the Minister of Justice, by W. E. Hodgins), Ottawa, 1896. 1447 pp., 8°.

Correspondence, Reports of the Ministers of Justice and Orders in Council upon the Subject of Provincial Legislation; 1867-1895. Compiled under the Direction the Honourable the Minister of Justice, by W. E. Hodgins.

Correspondence, Report of the Minister of Justice and Orders in Council upon the subject of Provincial Legislation, etc., 1896-1898, (by W. E. Hodgins), Ottawa, 1900, 414 pp., 8°.

Correspondence, etc., 1889-1900, (by W. E. Hodgins), Ottawa, 1902, 175 pp., 8°.

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MUNICIPAL OWNERSHIP. Municipal Trading and Municipal Ownership, or Operation of Public Utilities. To which is added the Return ordered by the Legislative Assembly on 12th June, 1903, of the Reproductive Undertakings operated by Municipalities in Ontario. Printed by order of the Legislative Assembly of Ontario. Toronto, 1903. 246 pp., 8°.

Annual Reports of The Union of Canadian Municipalities

(14)

RESOLUTIONS AND CONSTITUTION of the Canadian Municipal Union adopted at the Convention held in the City of Toronto, August 28th, 29th and 30th, 1901. Toronto, 1901. Pamphlet, 8pp., 8°.

THE UNION OF CANADIAN MUNICIPALITIES. Its Objects and Work. Interim Report by the Executive Committee, May 10th, 1902. Montreal, 1902. Pamphlet, 7 pp., 8°. (This was the first Annual Report.)

Second Annual Report. Montreal, 1902. 100 pp., 8°.

Third Annual Report. Montreal, 1903. 132 pp., 8°.

Fourth Annual Report. Montreal, 1904. 135 pp., 8°.

Fifth Annual Report. Montreal, 1905. 4°. (November number (1905) of the Canadian Municipal Journal.)

Sixth Annual Report. Montreal, 1906. 4°. (November number (1906) of the Canadian Municipal Journal.)

Seventh Annual Report . Montreal, 1907. 4°. (October number (1907) of the Canadian Municipal Journal.)

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Ninth Annual Report. Montreal, 1909. 4°. (October number (1909) of the Canadian Municipal Journal.)

TENTH ANNUAL REPORT, Montreal, 1910, 4° (October number, 1910, of the Canadian Municipal Journal.)

BIBLIOGRAPHY RELATING TO THE LAW OF WATERS

AT the present time there is no satisfactory treatise, or digest, setting forth the common, statute, and the case law in their application to waters and water privileges in the Dominion of Canada. In the United States, however, experience has, in several well-marked instances, prompted digests of the laws relating to waters.

It is highly desirable that comprehensive and summary digests be made by competent authorities, of the laws and decisions which relate, directly or indirectly, to the waters of the Dominion, and of the various provinces, both surface and underground. In the case of the Dominion of Canada, tbe scope of a research such as is suggested should include the international law applicable to the international waters and waterways. Such digests would serve as a guide to future conservation legislation, making it possible to utilize the waters in each particular instance, in the most efficient manner.

Since no descriptive list of digests, text-books, and treatises relating to the laws of waters has been published, it has been considered advisable to give here a bibliographical list of works relating to the law for waters and other cognate matters. The fuller titles of the respective volumes are given, and the works have been grouped under certain broad subject headings.

SUBJECT CLASSIFICATION

BOUNDARIES AND FENCES. Hunt.

DITCHES AND DRAINS. Cameron, Clarke and Scully, Farnham, Giaugue, Henderson, Proctor.

EASEMENTS. Blyth, Coulson and Forbes, Farnham, Gale, Goddard, Gould, Innes, Jones, Theobald.

IRRIGATION. Farnham, Kinney, Mills.

MINING WATER RIGHTS. Blanchard and Weeks, Morrison and DeSoto.

POLLUTION. Farnham, Fitzgerald, Garrett and Garrett, Haworth, Higgins, Moore and Moore, MacMorran and Willis, Will (Michael and Will,) Williams, Yool.

RIPARIAN RIGHTS. Angell, Coulson and Forbes, Farnham, Gilmore, Gould, Phear, Pomeroy, Round, Schultes, Wiel.

RIVERS. Angell, Coulson and Forbes, Cutler, Durie, Farnham, Ferguson, Gould, Higgins, Houch, Hunt, Jelf; Laws of the U.S.A., etc.; Musgrave, Tyler, Webster, Willcock, Woolrych.

SEA-SHORE. Coulson and Forbes, Ferguson, Gould, Hale, Hall, Hunt, Jerwood, Moore, Phear, Tyler, Willcock, Woolrych.

AUTHOR CLASSIFICATION

The following terms are given as suggestive headings under which the indices of the books may be profitably consulted:

AQUATIC RIGHTS — BOUNDARIES — CANALS — DRAINS — EASEMENTS — FENCES — FERRIES — FLOODS — FORESHORE — IRRIGATION — LAKE — NAVIGATION — NAVIGABLE RIVERS — NUISANCES — PERCOLATING WATERS — POLLUTION — POND — POWER — RIPARIAN RIGHTS — RIVERS — SEA-SHORE — SHORE — STREAMS — SUBTERRANEAN WATERS — TIDE WATERS — UNDERGROUND WATERS — WATERS — WATER-POWER — WATER PRIVILEGES.

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INDEX

A

PAGE

Aberdeen..... 121
Abitibi lake.....16, 193
Abitibi river..... 138
Acadia Powder Co..... 208
Achigan river..... 173
Actinolite..... 109
Actonvale..... 186
Adams lake and river..... 321
Agawa river..... 131
Agnes river..... 127
Agriculture, effect of water-power development on..... 3
Agriculture, value of ground water to..... 3
Agwanus river..... 190
Ahmic Lake dam..... 126
Albany rapid..... 137
river..... 136
Alberta, summary of power developed in..... 22a
Alberta Railway and Irrigation Co. 296
Alberta, stream-flow measurement in 290
Alberta, water-powers, list of..... 293
Alberta, water-powers of.....275, 285
Albert lake..... 214
Alexandria..... 107
Alex river..... 189
Algoma Power Co.....34, 131
Allagash river, discharge measurements..... 245
Allagash river, daily gauge elevations..... 246
Alliston..... 123
Allumette rapid..... 149
Almonte..... 144
Alpena falls..... 223
American Civic Association, action of, *re* Niagara power..... 56
American companies at Niagara Falls, list of..... 90
American Scenic and Historical Society, action of, *re* preservation of Niagara falls..... 56
Amy falls..... 136
Anderson lake..... 322
Andover..... 273
Andrewsville..... 145
Ange Gardien..... 176
Annapolis.....203, 222
Annapolis county..... 204
Annie Rooney rapid..... 124
Ansley Morgan mill site..... 222
Appleton..... 144
Apron Rock fall..... 216
Arkona..... 119
Arnprior.....143, 144
Aroostook fall..... 272
Aroostook river....230, 241, 255, 272
Arrow river..... 133
Arva..... 118
Ashburton treaty, reference to..... 235
Ashwapmuchuan river.....159, 189
Asessippi..... 291
Assiniboine river..... 291
Athabaska river..... 287
Athens, estimated cost of power in.. 55
Atik river..... 193
Atkinson and Sullivan dam site..... 267
Aubrey fall and rapids..... 129
Auburn mills..... 110
Auburn Woollen Co..... 110
Aumond rapid..... 142
Ausable river..... 119
Auxiliary power plants, Nova Scotia, 205
Avon fall..... 224
Avon river..... 224
Ayr..... 115

B

Babine lake..... 323
river..... 323
Bad fall.....219, 220
Baker brook..... 274
Baker lake..... 274
Bala fall.....7, 124
Baldwin creek..... 185
Baldwin mills..... 185
Ball Alley dam site..... 211
Baltimore..... 111
Bancroft..... 142
Banff..... 290
Banff fall.....286, 294
Bangs fall..... 217
Barber creek..... 111
Baribeau fall..... 172
Baring dam..... 264
Barnaby river..... 268
Barret chute..... 143
Barrier river..... 292
Barrington river..... 219
Bartholomew river..... 268
Bar-U ranch..... 297
Batchawana river..... 130
Bathurst Electric Co..... 269
Batiscan river.....159, 177
Battle, Est. J..... 114
Battleford..... 292
Battle river..... 292
Baxter creek..... 111
Bay du Vin (Northumberland Co.).. 267
Bayfield river..... 119
Bay lake, Montreal river, power of.. 34
Bay Spring lake..... 202
Beach, C. A and B. A., water-power leased by..... 34
Beach, M. F..... 106
Beachville..... 117

	PAGE
Beachy rapids	268
Bear creek	289
Bear fall	217
Bear river, B.C	320
Bear river, Ont	34
Bear river, N.S.....203, 221,	222
Bear River electric light plant	222
Beauharnois	187
Beauharnois canal	187
Beaver-bank Lake district	208
Beaver creek	109
Beaver falls	132
Beaver portage	137
Beaver river	122
Beaverton	123
Becaguimec river	241
Bécancour river.....166,	184
Beck, Hon. Adam.....40, 44,	53
Bedford	187
Bedford Mills	145
Bed of Navigable Waters Act	340
Bellacoola river	323
Belle river	179
Belleisle creek	270
Belleville	108
Bell fall	130
Bell river	193
Belly river.....189, 290,	294
Bentinck North arm	323
Benton	271
Bennett falls	220
Berlin, meeting of manufacturers at	37
Berlin, power prices in	50
Bersimis river.....161,	191
Bibliography	347
Big chute, Severn river.....34,	124
Big creek	117
Big fall, Liscomb river	211
Big fall, Liverpool river	218
Big fall, Odell river	271
Big Bear lake	129
Big Eddy fall	170
Big Liscomb dam	211
Big Pond river	228
Big Salmon river	288
Big Still rapid	211
Bignell, J	161
Bilskey, A. M	34
Birch Cove lake	208
Birdtail creek	291
Birkenhead river, B.C	322
Birthday rapid	289
Birtle	291
Bishop Crossing	184
Bitobi rapid	170
Blackadar mill	220
Black and Son	113
Black cañon	324
Black creek, N.S	227
Black creek, Ont	118
Black Donald Graphite Co	34
Blackfalds	294
Black fall	148
Black Hole	119
Black Jaws	272
Black rapid	145
Black Rattle, Lahave river	216
Black river, Ont. (Georgian bay)	132
Black river, Ont. (James bay)	138
Black river, Que	186
Black river, Sask	292
Black Sturgeon river	133
Blackville	268
Blackwater river.....320,	322
Bladder rapid	289
Blackberry river	319
Blaeberry river	319
Blakiston brook.....287,	294
Blanche river	139
Blind river	129
Blindman river	294
Bloody creek (also known as Currel brook which see)	222
Bloomfield	108
Blue river	321
Bluet fall	169
Board Camp fall	210
Bobcaygeon	110
Bocabec river	265
Bogart creek	124
Boiler rapid	293
Bolton	112
Bonaventure river	181
Bonhomme fall	189
Bonnechère river	141
Bonnet lake	212
Bonnington falls	318
Boom rapid	170
Borron, E. B.....16,	17
Bostonnais river	175
Boundary falls.....318,	319
Boundaries, reports *re*	368
Bow river.....286, 290,	294
Bowers dam	219
Bowmanville	111
Boyne river	123
Bracebridge.....34,	125
Bracebridge fall	125
Brady lake	139
Brampton, power prices in, statement *re*	50
Brandon, falls near	291
Brandon Electric Light Co	291
Brantford	115
Breakneck falls	137
Breeches lake	184
Bridge rapids	128
Bridgetown, N.S	203
Bridgetown, power plant at	222
Bridgewater Electric Light Co	217
Bridgewater, N.S	203
Brink rapid	292
Britannia rapid	147
Britain run, Tusket river	219
British American Land Co	185
British Canadian Power Co	139
British Columbia Electric Railway Co.....317,	318
British Columbia, irrigation water rights in	295

PAGE
British Columbia, summary of power developed in... 22a
British Columbia Water Act... 301
British Columbia, water-powers of.. 303
British Columbia water-powers, districts of... 316
British Columbia, water-power how disposed of... 301
Broad river... 218
Brockville, estimated cost of power in... 55
Brome... 186
Brome lake... 186
Broughdale... 117
Brown's dam... 269
Brulé rapid... 293
Brunswick rapids... 137
Buck Deer falls... 138
Buckhorn rapid... 110
Buckingham... 169
Buffalo Railway Co... 82
Bull river... 319
Bully rapid... 170
Buntzen lake... 317
Burgess saw-mill... 273
Burks falls... 126
Burleigh fall... 110
Burnaby... 318
Burnsville... 269
Burnt-camp rip... 221
Burnt chute, Wanapitei river... 34
Burnt fall... 170
Burntland brook... 268
Burnt river... 111
Burpee mill-dam... 271
Burrard inlet... 317
Burrard Power Co... 311
Burton Act, United States... 64, 65
Burton fall... 136
Buttle lake... 322
Byng inlet... 126
Byron dam... 117
Byron mills... 117

C

Cain bridge... 268
Calabogie rapid... 143
Caledonia, Ont... 115
Caledonia Mill Co... 115
Calgary... 288. 294
Calgary Power Co... 294
Calgary Water Power Co... 294
Calumet... 169
Cambria... 169
Cambria river... 169
Camel brook... 241
Camel chute and rapid... 143
Camden East... 108
Cameron fall, East river Sheet Harbour... 210
Cameron fall, Sable river... 129
Cameron rapid, Nipigon river... 132
Camp Lake fall and rapid... 211
Camp Miner rapid... 132
Campbell chute... 127
Campbell fall... 218
Campbellford municipal electric plant... 109
Canada Coloured Cotton Co... 106
Canada, Niagara power reserved for. 67
Canada, water-powers developed in, summary of... 22a
Canada, Western, irrigation in... 293
Canadian Annual Review, reference to... 35
Canadian Copper Co... 127
Canadian Cotton Mills Co... 264
Canadian Electric Light Co... 153
Canadian Electric and Water-Power Co... 145
Canadian Niagara Power Company, ... 62, 65, 67, 69, 71, 72, 113
Canadian Northern railway... 321
Canadian Pacific Ry. irrigation block ... 297, 298, 300, 302
Canal... 290, 297
Canadian Pacific Ry... 128, 297, 321
Canadian Pacific Ry. crossing, Vermilion river... 128
Canal rapids... 126
Canals, reports *re*... 364
Canoe river... 319
Canoose rips... 265
Cape Breton... 225
Caraquet river... 269
Cardinal... 106
Cardinal, estimated cost of power in. 55
Cardston... 290
Cariboo lake... 322
Cariboo mountains... 322
Caribou falls, Shipshaw river... 189
Caribou rapid, English river... 135
Carillon rapid... 146
Carleton Place... 144
Carnes river... 319
Caron chute... 178
Carter dam... 118
Carvill grist mill dam... 271
Carr's carding mill dam... 222
Carr's mill dam... 224
Cascade, B.C... 318, 319
Cascade, Ingram river... 215
Cascade, Vermilion river... 128
Cascade rapid... 291
Cascade Water, Power and Light Co. 318
Cascades, Gatineau river... 170
Cascades, Current river... 133
Cascades, Pigeon river... 133
Cascades, rapids, St. Lawrence R. 164, 187
Cat fall... 193
Cataract fall... 129
Cataract Co., De Cew fall... 114
Cataract Power & Conduit Co... 92
Catfish lake... 140
Cat Portage fall... 131
Catwohey fall... 125
Causapscal... 181

	PAGE
Causapscal river	181
Cave rapid	149
Cayoosh creek	322
Cedar lake	140
Cedar rapid, Gatineau river	170
Cedar rapid, Madawaska river	143
Cedars rapid, St. Lawrence river	93, 164, 187
Central lake	322
Central section, C.P.R. irrigation block	302
Centreville	272
Chain rapid	143
Chambly	187
Chambly basin	165
Chambly canal	187
Chambly Hydraulic and Mfg. Co	152
Champlain lake	187
Chapleau	138
Chapman chute and rapid	127
Charest river	177
Charles lake	208
Charlo river	269
Charlton	128
Chateauguay river	187
Chats falls, Ottawa river	147
Chaudière fall, Ashwapmuchuan river	189
Chaudière fall, Chaudière river	183
Chaudière fall, French river	127
Chaudière fall, Ottawa river	147
Chaudière fall, River du Loup	172
Chaudière river	163, 183
Chelsea, Que	156
Chelsea rapid	170
Chenaux rapid	147
Chesley, Ont	120
Chesley, N.S	216
Cheslatta lake	322
Chezzetcook lakes	209
Chiblow lake	129
Chicoutimi falls	178
Chicoutimi river	160, 178
Chilcoten river	320, 322
Chilko lake	322
Chilko river	322
Chilliwak river	321
Chimney creek	321
Chippawa river	130
Chute à Caron	178
Chute aux-Trembles	172
Chute des-Aulnaies	175
Chute fall	216
Chute de l'Anse-Creuse	178
Chute de l'Equerre	189
Chute des-Pères	179
Chute des-Piles	174
Chute de-Poste	172
Chute Plate	177
Clark City	180
Clark mill dam	271
Clarke, Thos	34
Clay portage, Matabitchuan river	34
Clear creek	117
Clearwater rapid, Magdalen river	192
Clearwater river	287
Clyde river, N.S	219, 226
Clyde river, Que	143
Clyde River Pulp and Paper Co	219
Coal and steel industries in Cape Breton	203
Coast range	322
Coaticook river	185
Coaticook River Water-Power Co	153
Cobalt	139
Cobalt Hydraulic Power Co	139
Cobalt Power Co	139
Cobden	141
Cobourg brook	111
Cocagne river	267
Colchester county, N.S	204
Cold creek	109
Coldwater	123
Coldwater river	123
Cole rapid, North Saskatchewan river	286, 292
Colonial Dames of America, action of, *re* Niagara power	56
Columbia River basin	319
Columbia River watershed	316
Columbia valley	295
Collingwood	123
Comeau mill	220
Como lake	202, 210
Commission of enquiry *re* Ontario water-powers	42
Connell, Dr. W. T	10
Conestoga	116
Conestoga river	116
Conjuror chute	137
Conrad Circle Cattle Co	297
Conrad lake	209
Constaw creek	142
Conquerall fall	217
Coquihalla river	322
Coquitlam	318
Coquitlam lake	317
Coral rapids	138
Corbeau rapid	170
Corbett mill-dam	222
Cornell fall	222
Cornwall	106
Cornwall Electric Light & Street Ry. Co	106
Côte St. Paul	188
Coteau, rapid	164
Coteau, Cedars and Cascades rapids	187
Cotton chute	143
Cottonwood cañon	320
Cowan, O. D	107
Cowan and Britton, Messrs	107
Cowansville	186
Cowichan lake	322
Cowie fall	217
Cowley	290
Cowpen fall	218
Cook mill	220
Coon pond	214
Coucher lake	214
Coulston gorge	193

	PAGE
Cran-Serré rapid	178
Crawford rapid	148
Credit river	112
Creemore	123
Croft Lumber Co	126
Crosby mill	220
Cross creek	270
Cross lake, N. B	274
Cross lake, Northwest Territory	289
Cross river, B.C	319
Crow rapid, Missinaibi river	137
Crow river	109
Crown lands, Ontario, water-power on, regulations *re*	24
Crown Lands Act, Nova Scotia, 1910,	197
Crowsnest river	287, 294
Crook Bros., Messrs	120
Crooked chute	141
Crooked fall	211
Crooked rapid, Athabasca river	293
Crooked rapid, Ottawa river	149
Crooked rapid, Sable river	129
Crouse	217
Crousetown	217
Culbute rapid	148
Cumberland county	204
Curtain chute	124
Currel brook*—see Bloody creek	222
Current river	133
Cypress fall, Mattagami river	137
Cypress rapid, Quinze river	168

D

	PAGE
Dacre	142
Daisy lake	323
Dalgleish rapids	121
Dalles rapid	127
Dargie mill	222
Dargis rapid	147
Dartmouth lakes	208
Darwin fall	173
Dauphinee lake	215
Daury mill	215
David river	186
Davidson dam	214
Davison Lumber Co	217
Davy, James	114
Dawson, A. S., on irrigation	295
Day, Fred E	34
Dean river	323
Deer Lake dam	126
Delaware	117
Delhi	117
Demicharge rapid	174
Denison falls	131
Dennis run	219
Denny dam	120
Derby	122
Deschênes rapid	143, 147
Des Chutes river	272
Des Eaux rapid	170
Deserter cañon	324
Des Islets fall	177
Desjardins rapid	148
Des Joachims rapid	149
Desmeules township, Que	189
Detweiler, D. B	38
Deux Rivières rapid	149
Deveau mill	220
Devil falls	137
Devil Lake creek	145
Devils Back fall	218
Devils fall	189
Devils Island fall	221
Devil jaw	223
Devil river	169
Dexters dam	117
Dickie's driving dam	212
Digby county, N.S	204
Digdeguash river	265
Discharge data and curves *re* St. John river, explanation of	242
Disraeli	184
Dixville	185
Doane dam	219
Doctor island	268
Dog fall	133
Dog river	131
Dolliver Mining Co	212
Dominion Lands Act, regulations *re* power	275
Dominion Leasing Co	210
Dominion Power and Transmission Co	90
Donkin, Hiram, on deforestation	198
Dorchester	117
Dorchester Electric Co	183
Dories run	223
Douglas mill-dam	270
Downie river	319
Driver river	323
Drummondville	184
Dryden	135
Dryden falls, Wabigoon river	34
Duck run	212
Ducks, The, rapid	143
Dufferin Light & Power Co	123
Duffin brook	111
Duncan river	320
Dundas	50, 112
Dundas creek	112
Dunnville	115
Durham	121
Durkee mill	220
Dutch river	319

E

	PAGE
Ear rapid	135
East Angus	184

* Information received since page 222 went to press gives Currel brook a head of 280 feet. One hundred and fifty horse-power have been developed to light the town of Bridgetown.

PAGE

Eastern Ontario Municipalities Power Union..... 53
Eastern section, C.P.R. Irrigation block..... 300
Eastmain river.....166, 167, 193
Eastman..... 187
East river..... 214
East river Pictou.....212, 227
East river Sheet Harbour..... 210
Eaton chute..... 170
Eaton dam..... 264
Eaton river..... 185
Ebb-and-flow rapid..... 289
Écarte rapid..... 133
Echo lake..... 209
Ecumsecum fall..... 211
Ecumsecum river..... 211
Edmundston..... 274
Edwards mill-dam..... 273
Edwardsburg Starch works..... 106
Eel river..... 271
Eel river falls..... 271
Eganville..... 141
Eight-foot fall..... 291
Elbow river.....287, 290
Electrical Development Co. of Ontario...62, 65, 67, 69, 78, 79, 113
Electric Co. dam..... 267
Electric Mfg. Co..... 113
Electric power, Act to regulate exportation of, from Canada..... 66
Electric power, apportionment of costs in Ontario..... 51
Electric power legislation in Ontario, 1906..... 44
Electricity and Fluid Exportation Act..... 341
Regulations under..... 344
Elk river..... 320
Elliott fall..... 111
Ellis mill..... 213
Ellis river..... 228
Elora..... 115
Embro..... 117
Emmerson farm, Green river, N.B.. 274
Emory, W. J. H..... 34
Enderby..... 321
Enfield..... 226
English river.....135, 284
Erie canal.....63, 69
Erie Ontario Power Co..... 85
Erie lake, tributaries of.....115, 118
Erie lake, physical factors of..... 93
Ernst, E. A..... 215
Escoumains river..... 180
Espanola..... 127
Etchemin river.....163, 183
Eugenia fall..... 122
Eureka dam (West branch)..... 212
Evaporation in Maine..... 239
Exeter..... 119
Expropriation Act, reference to.... 316
Export of power, license form..... 346

PAGE

F

Fairwell creek..... 289
Falls Power Co..... 77
Fancy lake..... 217
Farmer rapid..... 170
Farms, ready-made..... 300
Farnham..... 186
Fault saw-mill..... 217
Fenelon falls..... 111
Fenerty's old dam..... 213
Fer-à-cheval rapid..... 174
Fergus..... 115
Ferrée river..... 183
Ferrona junction..... 212
Fifteen-mile river..... 210
Finlay river..... 324
Fishing lakes..... 324
Finkle, F. C., statement of, *re* underground waters..... 5
First chute, Bonnechère river..... 142
First lake, N.B..... 274
First lake, N.S..... 208
First rapid..... 149
Fish creek..... 290
Fisheries jurisdiction..... 376
Fish rapids..... 137
Fish river.....209, 251, 252
Fishways and dams..... 199
Five-mile rapid..... 127
Flaglor brook..... 270
Flat river, Magdalen river..... 192
Flat rapid, Ottawa river..... 149
Flat river..... 320
Flat-rock rapid.....132, 221
Flesherton electric light plant..... 122
Fletcher locks..... 208
Foley-Reiger Co..... 114
Forests and inland waters, N.S.... 198
Forests, effect of, on water-powers.. 3
Fork falls..... 137
Forks dam..... 266
Fort Frances, Koochiching fall..... 134
Fort George..... 320
Fort William..... 133
Fort Selkirk..... 288
Foster's mill..... 141
Fountain fall..... 139
Fourneau rapid..... 149
Fourth chute, Bonnechère river.... 141
Fowler fall..... 270
Frances river..... 288
Français lake..... 322
Frank..... 294
Frankford..... 109
Frankfort..... 109
Franklin, district of..... 282
Fraser Bros..... 272
Fraser cañon..... 321
Fraser lake, B.C..... 322
Fraser lake, N.S..... 202
Fraser mill-dam.....272, 274
Fraser river.....322, 323
Fraser River basin..... 320
Fraser River watershed..... 316

PAGE
Fraserville..... 183
Fredas..... 216
Frederickhouse river..... 138
Freeman dam..... 218
Freeport..... 186
Frenchman river..... 289
French mill-dam..... 219
French river..... 127

G

Gabelle rapid..... 174
Gagnon chute..... 179
Galets fall..... 189
Galetta..... 144
Galetta Electric Power Co..... 144
Galops rapid..... 107
Galt.....44, 50, 115
Gananoque..... 107
Gananoque river..... 107
Ganaraska river..... 111
Gannet rip..... 221
Gardens.....218, 227
Garry river..... 107
Garvin chute..... 148
Gaspereaux..... 213
Gaspereaux fall..... 210
Gaspereaux river.....223, 227
Gatineau river.....156, 170
Gauvin, C. E..146, 147, 148, 155, 157
Gavel run..... 220
Geddes Bros..... 143
Georgetown..... 112
Georgian Bay Power Co..... 122
Georgian bay, tributaries of, 122, 124, 126
Gibson lease..... 106
Gibson, Thos. W..... 24
Gibson, W. S..... 107
Gilman and Burden, Messrs..... 271
Gladstone..... 129
Glasier lake..... 274
Gleason brook..... 122
Glencairn..... 123
Glencross rips..... 211
Glen Huron..... 123
Glen Lewis..... 109
Glen Miller..... 109
Glen Roden..... 121
Glen Ross..... 109
Glodes fall..... 217
Godbout river..... 191
Goderich..... 119
Gold creek, Alta..... 294
Gold river, N.S..... 215
Goldstream river..... 319
Gordon Pulp and Paper Co..... 34
Goulais river..... 130
Gould creek..... 141
Governor lake..... 202
Governor Lake dam..... 210
Granby..... 186
Grande chute, Batiscan river..... 177
Grande chute, Magdalen river..... 192
Grande-Baie..... 178
PAGE
Grande-Ile..... 178
Grand Calumet fall and rapid..... 147
Grand discharge..... 189
Grand du Bonnet fall..... 291
Grand fall, Hamilton river..... 190
Grand fall, Nine-mile river..... 213
Grand falls, St. John river.....
.....241, 257, 261, 262
Grand Forks, B.C.....318, 319
Grand lake.....210, 213
Grand'mere fall..... 174
Grand rapid, Mattagami river..... 137
Grand rapid, Nelson river..... 289
Grand rapids, Athabaska river 287, 293
Grand rapids, Saskatchewan river.. 286
Grand river, N.B..... 273
Grand river, Ont..... 115
Grand sault..... 182
Grand Trunk Pacific Ry. .320, 321, 323
Granite Works dam, Bear river..... 222
Gravenhurst..... 125
Graveyard chute..... 128
Great Bear fall..... 189
Great cañon, B.C..... 323
Great fall..... 189
Great rapids, Long portage..... 137
Great Slave lake..... 317
Green Hill rapids..... 137
Green lake.....322, 323
Green river, B.C..... 322
Green river, N.B..... 273
Greenwood, B.C.....318, 319
Greenwood, Ont..... 111
Grenville..... 169
Grey rapids..... 268
Guelph..... 50,116
Guimond fall..... 178
Gull rapid..... 289
Gull river..... 132
Gundy, The, Weymouth river..... 221
Guzzle fall..... 217

H

Ha-ha river..... 178
Haley mill..... 220
Halifax county, N.S..... 204
Halifax, mainland east of, 208, 209, 210,
.....211, 212
Halifax, mainland west of, 213, 214, 215,
217, 218, 219, 220, 221, 222, 223, 224
Hamilton Cataract Power Co., rights
granted to..... 87
Hamilton Cataract Power Light &
Traction Co.....87, 114
Hamilton Electric Light & Cataract
Power Co., powers granted to... 88
Hamilton, power prices in..... 50
Hamilton river..... 190
Hamilton river, power possibilities of 161
Hand fall, Jordan river..... 218
Hand Lake dam..... 214
Hanover..... 120
Hanover electric light plant..... 120

PAGE

Hanover Portland Cement Co. 120
Hants county, N.E. 204
Hardwood rapid. 170, 171
Harley run. 219
Harlow dam. 218
Harlow & Freeman, Messrs. 218
Harmon. 217
Harmony pulp mill. 217
Harnish mill dam. 222
Harnish upper dam. 222
Harricanaw river. 166, 193
Harrington dam. 118
Harrington mill. 220
Harrison lake. 322
Hastings. 109
Havelock Electric & Power Co. 110
Haverstock mill. 214
Hawkesbury. 169
Hawkesbury Lumber Co. 147
Hay river. 317
Hayworth fall. 121
Hazelton, B.C. 323
Head rapid 168
Healey fall. 109
Hébertville 179
Hebb lakes 217
Heffler & Webber mill. 213
Hegan, James B., on inland waters of P.E.I. 229
Helen mine. 131
Hell gate. 137
Hemlock river. 218
Hemming fall. 184
Hensall. 119
Herron rapid. 143
Hervey dam. 219
Hespeler. 116
Hespeler, power prices in 50
Hicks dam. 219
High fall, Arrow river. 133
Blind river. 129
Bonnechère river. 141
Frederickhouse river. 138
Gatineau river. 170
Lièvre river. 155, 169
Madawaska river. 143
Michipicoten river. 34, 131
Mississippi river. 143
Moira river 109
Moon river. 124
Muskoka river. 34, 125
Onaping river. 128
Pigeon river. 133
Spanish river. 127
Wabi river. 139
Highland chute. 143
High river. 290
Highwood river 290
Hillsborough river, P.E.I. 228
Hodge, Wm., flour mill. 106
Hogsback rapid, Rideau river. 145
Holden lake. 215
Holgate, McDougall and Ker's report *re* power on Gatineau, quoted. 156

PAGE

Holgate, McDougall and Ker's report quoted *re* High fall, Lièvre river. 155
Holland river 123
Homathko river. 323
Hope, B.C. 321, 322
Hopewell. 227
Hornings mills 123
Horse Cross. 213
Horseshoe fall, Bow river. 286, 294
Hound chute, Montreal river. 34, 139
Howard dam. 224
Howard falls. 136
Howland, O. A., *re* organization of Union of Municipalities. 37
Howse pass. 319
Huberdeau fall. 169
Hulbert rapids. 219
Hull, George B., on irrigation. 295
Hull, Que. 147
Humber river. 112
Hunterstown fall. 172
Huntingdon. 187
Huron, lake, tributaries of. 119, 120
Hydraulic data, N.B. 237
Hydraulic and Manufacturing Co., St. Johns and Iberville, rights granted to. 153
Hydro-Electric Power Commission, contract with Ontario Power Company. 76
personnel of. 45
work of 49
additional powers granted to ... 46
functions of. 55
estimated cost of power to Eastern Ontario municipalities ... 55
prices charged for power delivered. 50
Ontario, powers vested in 24
reference to report *re* power sites 99
results of report of. 43
publications of. 351
Hyman, Ont. 127
Hyslop Bros., Messrs. 114

I

Illecillewaet river. 319
Iltasyouco river. 323
Imperial Paper Co. 127
Incomappleux river. 319
Indian brook, N.S. 225
Indian chute, Montreal river 34
Indian fall, La Have river 216
Indian fall, Nipisiguit river 269
Indian Gardens (Lake fall). 218
Indian rapids, Saugeen river, power 34
Indian river 141, 214
Industrial wastes, pollution of water by, N.S. 197
Ingersoll. 117
Ingersoll, power prices in ....

PAGE

Inglis mill..... 122
Ingram river..... 214
Innisville..... 143
Intercolonial Ry. bridge, Enfield, N.S. 226
"Inter-montane" valley, B.C..319, 320
International Boundary Waters Treaty, Art. VIII. of, quoted.... 7
International Boundary Waters Treaty, Art. VIII., ratification of 67
International Boundary Waters Treaty, text of..... 331
International Commission, River St. John.....235, 236, 237
International Joint Commission, *re* waterways, personnel and duties of..... 68
International Railway Company.... 113
International Railway Company, agreement of, with Queen Victoria Niagara Falls Park Commissioners 81
International Railway Company, permitted to import power into United States..... 65
International Railway Company, requests of, refused by Commissioners..... 83
International Waterways Commission.....6, 61, 64, 367
International Waterways Commission, origin of..... 59
International Waterways Commission, work done by, *re* Niagara power..... 58
Irrigation Act.....278, 281, 282
Irrigation, water rights in British Columbia..... 295
Irrigation in Western Canada..... 295
Iroquois..... 106
Iroquois fall, Rouge river..... 169
Iroquois fall, Vermilion river..... 175
Iroquois fall, pumping and electric plants..... 106
Iroquois rapid..... 174
Iroquois river..... 274
Isaac Harbour river..... 212
Island chute..... 137
Island fall, Barrington river..... 219
Island fall, East Main river..... 193
Island fall, Mattagami river..... 137
Island fall, Seine river..... 134
Island portage, Moon river..... 124
Island portage, Nipigon river..... 132
Island rapid, Mississippi river..... 143
Island rapid, Quinze river..... 168
Island rapid, Sable river..... 129
Island rapid, Vermilion river..... 128
Ivy, "The Fishery"..... 123

J

Jackfish..... 132
Jackson, G. Y., water-power leased by..... 34
Jacob rapid..... 126

PAGE

Jacques Cartier river..... 176
Jacques Cartier river, power possibilities of..... 159
Jacquet river..... 269
Jam fall..... 209
James Bay watershed, E. B. Borron quoted on..... 17
James fall..... 216
Jeannotte river..... 177
Jeddore lakes..... 209
Jemines rips..... 223
Jesus river..... 146
Jodrie fall..... 216
Johnston rapids..... 149
Johnston, D. W., quoted *re* law on underground waters..... 5
Johnston, S., water-power leased by. 34
Joint Commission *re* St. John river, appointment of..... 236
Joint Commission, personnel of..... 236
Joint Commission, scope of, defined. 237
Joliette..... 173
Joli Fou rapids..... 293
Jolly Lake dam..... 222
Jolly Lake fall..... 222
Jones & McGill dam..... 219
Jones creek..... 270
Jonquières..... 179
Jonquières Pulp Co., power used by. 160
Jordan River watershed, B.C..... 318
Jordan stillwater..... 211
Jordan river..... 226
Jumpingpound creek..... 290

K

Kabinakagami river..... 136
Kakabeka fall..... 133
Kakaki rapid..... 168
Kakozhisk river..... 138
Kaministikwia river..... 133
Kaministikwia river, water-powers of..... 34
Kaministikwia Power Co..... 133
Kamloops..... 321
Kamouraska..... 183
Kamouraska river..... 183
Kananaskis falls, Bow river....286, 294
Kananaskis river..... 286
Kapuskasing river..... 138
Kawashkagama river..... 136
Kaulbach..... 217
Kearney Lakes district..... 208
Kearney lake, outlet of..... 208
Kebsquashing river..... 138
Kegashka river..... 190
Kemano river..... 323
Kemptville electric supply..... 145
Kenogami falls..... 136
Kenogami river..... 136
Kenogamisi falls and rapids..... 137
Kenora, water-power leased by..... 34
Kenora electric plant..... 134
Kettle fall and rapids, Abitibi river. 138

PAGE

Kettle fall, English river..... 135
Kettle rapid, Nelson river..... 289
Kettle rapid, Missinaibi river..... 137
Kettle river, B.C..... 320
Keyhole rapid..... 211
Keyhole..... 211
Kiask fall..... 193
Kicking Horse river..... 319
Kilgorie..... 123
Kilkenny..... 173
Kimball..... 290
King rapid..... 143
Kingsbury..... 185
Kings county, N.S..... 204
Kingston, estimated cost of power in 55
Kinmount..... 111
Kipawa river..... 171
Kippen..... 119
Kitimat river..... 323
Kitlope river..... 323
Klinaklini river..... 323
Kneopfle rapid..... 126
Kneeland dam..... 223
Knife rapid..... 124
Knight Bros., Messrs..... 126
Knotts dam..... 118
Koochiching falls..... 138
Kootenay river..... 319
Kouchibouguac river..... 267
Kutz, Capt. Chas., extract from report by, *re* Niagara falls..... 60
Kutz, Capt. Chas., investigation of *re* Niagara power..... 59

L

Lachine rapids..... 188
Lachute.....
La Cloche fall..... 169
Lacolle..... 187
Lacolle river..... 187
Lacombe electric plant..... 292
Ladle Lake dam and rapid..... 211
Langelier, J. C., quoted *re* forests on Ashwapmuchuan river..... 159
Langelier, J. C., quoted *re* power on Magdalen river..... 162
Lahave river (branch of)..... 216
Lake fall (Indian Gardens)..... 218
Lake Superior portage..... 131
Lake Superior Power Co..... 130
Lake of the Woods Milling Co..... 134
Lakes of Northern Ontario, list of.. 101
La Martine fall..... 179
Lamprey fall, Man..... 285, 291
Lanark rapid..... 143
Lansdowne, estimated cost of power in..... 55
L'Anse-de-Sable..... 178
Larchwood..... 128
Lardo river..... 320
Larry river..... 212
Last Falls rapids..... 177
L'Assomption river..... 173

PAGE

L'Assomption river, power possibilities of..... 157
Latchford rapid..... 140
La Tuque..... 174
Laurentides..... 173
Laurentides National Park, value of, as source of rivers..... 159
Lauzon fall..... 172
Lavender fall..... 123
Laveille creek.....140, 141
Law of waters, bibliography..... 372
Laws relating to inland waters of New Brunswick..... 230
Lowe, Thomas..... 142
Lease, form of, for water-powers in Ontario..... 29
Leases, water-power, in force in Ont. 34
Leckie, R. G., water-power leased by 34
Lee creek.....288, 294
Legislation of 1903 for municipal action *re* power in Ontario..... 41
Leslie fall..... 218
L'Epiphanie..... 173
L'Epouvante fall..... 179
Leighton, M. O., quoted on water-power in U.S..... 17
Lepreau river, N.B.....230, 266
Les Cascades, Metabetchouan river 179
Les Erables rapid..... 149
Les Escoumains..... 180
Les Forges rapid..... 174
Les Grés rapid..... 174
Lequille brook..... 222
Lewes river.....288, 317
Liard river.....288, 317
License regulations *re* water storage 282
License to export power..... 346
Lièvre river..... 169
Lièvre river, power possibilities of.. 155
Light, Heat & Power Co., of Lindsay 111
Lillooet..... 321
Lillooet lake..... 322
Lillooet river..... 322
Limestone rapid..... 289
river..... 273
Lincoln Electric Light & Power Co.. 113
Lindsay..... 111
Lindsay Light, Heat & Power Co... 111
Lindsay, proposed supply of electric energy to..... 55
Lintern river..... 265
L'Isle rapid..... 174
L'Islet fall..... 189
L'Islet rapid..... 148
Liscomb river..... 211
Liscomb Mills fall..... 211
Liskeard..... 139
Little Batiscan river..... 177
Little Bonaventure river..... 181
Little cañon..... 324
Little Cascade rapid..... 293
Little Cascapedia river..... 181
power possibilities of..... 162
Little chute..... 124
Little Discharge..... 178

PAGE
Little Mill dam. 266
Little fall. 265
Little river. 267, 274
Little river, St. John river. 273
Little Mill dam. 266
Little Indian Lake fall. 213
Little Lake fall. 214
Little Liscomb river fall. 211
Little Long falls and rapids. 137
Little Magog lake. 185
Little Paresseux rapid. 140
Little Peribonka river. 189
Little Presquile river. 271
Little Trout lake. 140
Little Twelve-Mile creek. 288
Little Welsh river. 210
Liverpool, N.S. 203
Liverpool electric plant. 217
Liverpool river 205, 217, 227
Livingstone river. 287
Lobstick rapids. 138
Loch Alva dam. 266
Lockhart dam. 267
Log driving. 200, 232
Logan mills. 209
Lockport Hydraulic Co., water diversion permitted. 65
London. 117
London, power prices in 50
Long cañon, B.C. 324
Long fall. 219
Long lake, N.S. 208
Long lake, Ont. 128
Long rapid, Abitibi river. 138
Long rapid, Ottawa river. 148
Long Rapid fall, Mattagami river. . . 137
Long Rapid fall, Sable river. 129
Long Sault, St. Lawrence river. . . 93, 107
Long Sault, Ottawa river. 147
Long Sault rapids, Abitibi river. 138
Long Sault rapids, Ottawa river. . . . 149
Long Slides. 109
Long Spruce rapid. 289
"Long Wharf of America". 200
Longley, J. 223
Longs fall. 220
L'Orignal rapid 169
Lorne. 184
Lorraine, south. 139
Loup, river du. 183
Loup, river du, power possibilities of 163
Low, A. P., quoted *re* Hamilton river 161
Lower Burnt chute. 126
Lower Great Brook fall. 218
Lower Niagara River Power & Water Supply Co., rights granted to. 92, 97
Lower Rocky lake. 202
Lucknow. 119
Lunenburg, N.S. 203
Lunenburg county, N.S. 204
Lunenburg Gas Company. 215
Lyn. 107
Lyn, estimated cost of power in. 55
Lyn river, power site on. 116
PAGE
Lynx Head chute. 134
Lynn Valley. 116
Lytton bridge. 321

M

Mabel lake. 321
Mackenzie, district of. 281
Mackenzie, James W. 198
Mackenzie river. 288, 317
Mackie mill. 216
Macmillan river. 288
Madawaska river. 142, 254, 253, 274
Maddington falls. 184
Mad river, B.C. 321
Mad river, Ont. 123
Magaguadavic Lake dam. 265
Magaguadavic river. 265, 266
Maganetawan river. 126
Magdalen river. 162, 192
Magog. 185
Magog river. 185
Magpie river. 131
Magnan fall. 172, 173
Mahone, N.S. 203
Maine and New Brunswick Electric Power Co. 273
Maine, evaporation records in. 238
Mair mills. 122
Maitland river. 119
Major lake. 209
Malay fall. 210
Mamewanimikan river. 132
Manotick. 145
Manchester fall. 173
Manikuagan river. 161, 191
Manitoba, water-powers of 22a, 275, 283
Manitou chute. 135
Manitou rapid. 170
Manitou river. 190
Maniwaki. 170
Manuan river. 175, 189
Manufacturers of Western Ontario, work of Committee *re* power. . . 40
Maple creek. 289
Maple hill. 120
Maple rapid. 168
Margaret Bay road. 214
Maritime Edge Tool Co. 265
Markdale. 121
Markham. 111
Marmora. 109
Marsden's mill. 214
Marshall fall, Bear river. 221
Marshall fall, East river Sheet Harbour. 210
Marshville. 114
Martin, C. A. 34
Martin, John. 34
Martin falls. 136
Martin river. 215
Marysville Mill dam. 270
Maskinonge river. 157, 172
Mason's mill. 214
Massawippi river. 185

	PAGE
Massey	128
Matabetchouan river	139
Mather Bridge and Power Co	84
Mathewson dam	118
Mattagami river	137
Mattambine river	172
Mattawa rapid	149
Mattawa river	213
Mattawan, township of	34
Mattawan Electric Light and Power Co	34
Mattawapika rapid	140
Maxwell mill	213
McAloney fall	223
McAndrew, J. A	34
McArthur fall, Winnipeg river	284, 291
McCabe lake	213
McCarthy chute	129
McCarthy fall	273
McCurdy fall	223
McDougall chute	138
McDougall fall	265
McGee, Dr. W. J., quoted on water as a resource	5
McGowan dam	121
McGrath fall	213
McIntieth rapid	211
McIntyre dam	120
McKechnie dam	121
McKee fall	129
McLeary and McLean, Messrs	114
McLellan and Shememan, Messrs	107
McLeod falls	189
McLeod mills	267
McLeod river, B.C	324
McMullen dam	212
McNab chute	127
McPherson fall	128
McTavish fall	169
McVittie, Wm	34
Meadow-lily dam	117
Meareau rapid	129
Meduxnekeag river	229, 271
Medway river	227
Megiskan river	193
Merrickville	145
Merritton	114
Mersey Hydraulic Co	196
Metagama rapids	127
Metagama station	127
Metagan river	220
Metabetchouan river	179
Meterings of rivers, N.S	206
Metis river	181
Mice rapid	148
Michaud dam	273
Michaud, J. L	164
Michipicoten river	131
Middle fall, Trent river	109
Middle lake, Sask	292
Middle rapid, Athabaska river	293
Midlanding rapids	269
Midland, Ont	55
Midway river	118
Midgell river	228
Milapskegechk lake	217
Mildmay	121
Miles, C. LeB	242
Milieu, rivière du	175
Millbrook	111
Miller and Son	218
Miller Bros	109, 272
Miller Island fall	219
Miller lake	208, 214
Mill lakes	209
Mill pond	209
Millstream, N.W	268
Mill street (Lachine canal)	188
Milltown	264
Mill village	217
Mill Village bridge	227
Milnikek river	181
Milton	112
Milton electric plant	217
Milton falls	217
Minamkeak lakes	217
Minatch river	323
Mines Power Ltd	34
Mining Company dam	212
Mining locations in Quebec, rights of owners *re* waters	152
Mining, power for, Nova Scotia	203
Minnedosa, falls near	291
Minnedosa Power Co	291
Minnisagua lake	129
Minto mine	134
Miramichi river	230, 268
Misinchinca river	324
Mispec fall	267
Mispec river	267
Missinaibi river	137
Missisquoi river	187
Mississagi river	129
Mississippi river, Ont	143
Mistassini river	160, 189
Mitchell	50, 118
Mitchell and Wilson, Messrs	107
Mitchell Lake dam	211
Moira river	108
Moir's paper mills	208
Moisie river	161
Mond Nickel Co	34, 128
Monquart river	241, 272
Monroe and Roantree, Messrs	114
Montague river	228
Mont-à-peine fall	173
Montizambert	131
Montmagny	183
Montmorency fall	176
Montmorency river	158, 176
Montreal Cobalt Co	34
Montreal Cotton Co	187
Montreal river	130, 139
Moody run	219
Moon chute	124
Moon river	124
Moose fall and rips	221
Moose river	186
Morgan fall	216
Morrell river	228

	PAGE
Morrisburg	55, 106
Morrisburg pumping and electric plants	106
Moser river	211
Mosher fall	215
Mosquito creek	290
Mountain chute	143
Mountain fall and rapid, Gatineau river	170
Mountain falls, Madawaska river	34
Mountain falls, Montreal river	34
Mountain portage	126
Mountain rapid, Ottawa river	147
Mount Joli village	181
Mount McKay and Kakabeka Falls Railway Co	34, 133
Muddy Saugeen river	121
Mulgrave lake and river	202, 210
Mulgrave Lake fall	221
Mullay rapid	211
Muniake river	272
Municipal ownership, reports on	370
Municipalities, Union of Canadian, reports of	371
Municipal power plants, Nova Scotia	201
Murchie and Son's mill	264
Murchie dam	273
Murderers bar, B.C	323
Murdoch fall	178
Murphy fall	177
Murray bay	176
Murray river, P.E.I	228
Murray river, Quebec	176
Mushamush river	215
Muskoka district	8
Muskoka river	122, 124, 125
Muskosibi river	179
Musquash river	230, 266
Musquodoboit river	209
Muskrat fall	190
Muskrat rapid	148
Muskrat river	141
Muskwaro river	190
Myers island	109
Myra fall	215

N

	PAGE
Nabisipi river	190
Nacawic river	271
Nagle dam	185
Nairn fall	127
Najualand lake	175
Nanticoke creek	116
Nanton	290
Napanee	55, 108
Narrows, The	269, 271, 272
Nashwaak river	270
Nass river	324
Natalkuz lake	322
Natashkwan river	161, 190
Nation river	324
National Conservation Commission	3
National Transcontinental Ry., datum secured from	241
"Natural Steps" dam	176
Naus	217
Nechaco river	320, 322
Nelson river	289
Nerepis	270
Nerepis river	270
New Brunswick, inland waters of, laws relating to	231
New Brunswick, water-powers of	22a, 230, 264
Newburgh	108
Newcastle creek	270
New Germany	216
New Hamburg	50, 115
New Liskeard Light & Power Co	139
Newmarket	123
New Richmond	181
New Westminster	317
New York and Ontario Power Co	54
Niagara falls, American companies at	90
Niagara Falls, apportionments of water recommended	62
Niagara Falls power, amount reserved for Canada	67
Niagara falls, power generated at	67
Niagara falls, undeveloped power sites at	98
Niagara County Irrigation & Water Supply Co	91
Niagara falls, æsthetic value of	57
Niagara Falls Electrical Transmission Co	92
Niagara Falls Hydraulic & Mfg. Co	63
Niagara Falls Hydraulic Power & Mfg. Co	65, 69, 91
Niagara Falls, municipality of	113
Niagara Falls Park & River Ry. Co.	62, 69, 82, 83
Niagara Falls Power Co	63, 65, 69, 91
Niagara falls, power possibilities of	95
Niagara falls, reports on	354
Niagara Falls Suspension Bridge Co	82
Niagara Falls waterworks	84
Niagara Gorge Power Co	91
Niagara Lockport & Ontario Power Co	78, 91
Niagara Power and Development Co	91
Niagara power companies, data respecting	60
Niagara power, general conditions governing development	92
Niagara Power Union	35, 45
Niagara river, discharge of	95
Niagara river, drainage area of	93
Niagara river, power development on	56
Niagara river, power of lower	97
Niagara river, rapids of lower	113
Niagara-Welland Power Co	84
Nichols dam	118
Nichols lake	213
Nicolet river	184

	PAGE
Nictaux river	223
Nigger rapid	169
Nimpkish lake	322
Nine-mile river	213
"Nine Partners," Tusket river	219
Nipigon river	132
Nipigon station	132
Nipisiguit river	269
Nipissing Central Ry	139
Nipissing Power Co	127
Nith river	115
Noisy river	123
Nomining river	169
North American Canal Co	85
North Arm power plant	317
North Bay	127
North Dunk river	228
Northeast river	214
North Hatley	185
North river, N.S	225
North river, Ont	110
North river, Que	168
North Pole branch (Miramichi R.)	268
Northern watershed, B.C	316
Northrop mill-dam	270
North Saskatchewan river	286, 287
Northwest Miramichi river	268
Northwest Territories, water-powers of	275, 289
Norval	112
Norway chute	143
Norway fall and rapids	127
Norwich	50
Norwood	110
Notch, The, Montreal river	139
Nottaway river	166, 193
Nottawasaga river	123
Nova Scotia, Crown Lands Act, 1910	196
Nova Scotia, inland waters of and tourists	199
Nova Scotia, law relating to waters, reference to	195
Nova Scotia, municipal power plants in	202
Nova Scotia, precipitation in	201
Nova Scotia, power for mining in	204
Nova Scotia Pulp & Paper Co	217
Nova Scotia rivers, meterings of	206
Nova Scotia, water-powers of	22a, 195, 204, 208
Noyé chute, Shipshaw river	179

O

	PAGE
Oak fall	219
Oakville	112
Oakville creek, Ont	112
Oakville mill dam, Meduxnekeag river	271
Oatmeal fall	193
O'Brien lake	210
Odell river	272
Ogilvie dam	224
Ogoki river	136
Oil creek	294
Okanagan river	325
Okanagan Water Power Co	318
Okotoks	290
Old dam, Ingram river	215
Oldfield mill dam	270
Oldman river	287, 290
Old Mill river	228
Old tannery dam, St. Croix river	265
Olomanoshibo river	190
Ombabika river	132
Omemee	111
Omineca river	324
Onaman river	132
Onaping chute	128
Onaping river	128
Ontario Bureau of Mines, information supplied by	324, 34
Ontario Distributing Co	77
Ontario lake, tributaries of	108
Ontario Power Co	62, 65, 67, 69, 73, 75, 76, 77, 113
Ontario Power Commission	41, 43, 351
Ontario Transmission Co	77
Ontario, water-power lease, form of	29
Ontario, water-power leases in force	34
Ontario, water-power legislation	23, 24
Ontario, water-powers of	22a, 23, 100, 106, 348
Ontario Wheel Works	107
Onwatin lake	128
Ootsabunkut lake	322
Opazatika river	137
Orangeville	123
Orford lake	187
Orillia	34
Orillia electric light and power plant	124
Ormstown	187
Oromocto river	270
Ortonville	241
Oshawa	111
Oshawa creek	111
Osier river	214
Oslinca river	324
Otella river	272
Ottawa	50, 147
Ottawa river	101, 146
Ottawa river, tributaries of	139
Otter creek	117
Otter creek, Saugeen river	121
Otter fall, Pennant river	213
Otter fall, Winnipeg river	291
Otter pond	215
Otter rapids, Abitibi river	138
Otter rapids, Mississippi river	143
Ouareau river	157, 173
Ouelle river	163
Ouiatchuan river and falls	179
Ouiatchuanish river	179
Ouse river	110
Outarde river	161, 180, 191
Outlet fall	136
Owen Sound	122
Owikano river	323
Oxbow falls	169

PAGE
Oxenden 122
Oxford 224

P

Pabineau fall 269
Pacific Coast watershed 314
Paipoonge 133
Paisley 120
Pakenham 144
Palliser river 319
Palmer rapid 142
Papermill lake 208
Paquette rapid 148
Paradise river 223
Paresseux chute 140
Paris, Ont 115
Parker fall 222
Parmeter & Bullock, Messrs 107
Parry Sound 126
Parry Sound Lumber Co 126
Parsnip river 324
Paugan fall and rapid 170
Peace river 286, 291, 317, 324
"Peace River Block" 275, 308
Pefferlaw brook 123
Pelican chute, English river 135
Pelican rapids, Athabaska river 291
Pelky mill 274
Pelly river 288
Pemberton meadows 332
Pembroke 141
Pemoka rapid 189
Pend d'Oreille river 320
Penman Mfg. Co 114
Pennant river 213
Pennsylvania, water-powers of 16
Penetanguishene 55
Pentecôte river 161, 191
Peribonka river 160, 189
Perth, N.B 272
Perth, Ont 143
Petawawa 140
Peterborough Hydraulic Power Co 110
Petitcodiac river 230
Petite chute à l'Ours 189
Petit-Pré River 176
Petit sault 192
Petite-Nation river 169
Petite rivière 217
Philip river 224
Phœnix 318, 319
Piapot creek 289
Pic river 131
Pictou county, N.S 204
Pierce mill dam 270
Pigeon fall, Michipicoten river 131
Pigeon river, Georgian bay 133
Pigeon river, lake Ontario 111
Piggott, D 114
Pike river 187
Pikitigushi river 132
Pinawa channel 285, 289
Pine fall 284, 289
Pine lake 212
Pine Portage rapid 132
Pine river 123
Pinkerton 120
Pipestone rapid 168
Playfairville 143
Plaster Rock 272
Plein Chant rapid and chute 140
Pogwa Lake dam 214
Point Robinson 114
Point du Bois fall 285, 289
Pokiok river 271
Pokiok site, St. John river, N.B 274
Pokiok stream (branch of Tobique) 272
Ponhook dam, St. Croix river 224
Ponhook fall, Port Medway river 217
Pont Rouge 176
Porcupine river 290
Port Arthur 50, 133
Port Dalhousie 113
Port Daniel 181
Port Daniel river 181
Port Dover 116
Port Hope 111
Port Hope Electric Light & Power Co 111
Port Medway river 217
Port Moody 318
Port Rowan 117
Port Severn 124
Port Stanley 117
Portage-du-Fort rapid 145
Portage chute 179
Portage falls, Kenogami river 136
Porter Mill stream 265
Portneuf 176
Portneuf river 176, 191
Portobello locks 208
Poultice fall 217
Pottawattomi brook 122
Poverty Bay rapid 126
Powassan chute 127
Powell lake 323
Powell river 323
Power Commission Act, 1911, summary of 48
Power Commission Amendment Act, Ont., quotation from 49
Power Commission Amendment acts, Ont 47
Power and light, standard schedule of prices for Ontario 52
Power for manufacturing, Nova Scotia 203
Power, recommendation *re* importation of into U.S 63
Power sites, upper St. John river 241
Power, transmission lines, construction of 50
Power and transmission companies holding Niagara franchises, list of 69
Prairies, rivière des 146
Precipitation in Nova Scotia 201
Precipitation, source of water-supply
Prescott 155

PAGE

Presquile river 271
Preston.....50, 116
Pretty river..... 123
Prices, standard schedule of, for power, Ont..... 51
Priceville..... 121
Prince Edward Island, inland waters of.....22a, 228
Prospect river..... 213
Puntzee lake..... 322
Purdy mill..... 121

Q

Quack lake..... 215
Quatre Pattes fall..... 170
Quebec water-powers, 22a, 150, 154, 370
Queens county, N.S..... 204
Queen's University..... 10
Queen Victoria Park, documents *re*. 357
Quesnel river..... 322
Quinze river.....155, 168

R

Rabital cascades..... 141
Rafter, Geo. W..... 13
Raft river..... 321
Ragged chute, Madawaska river.... 143
Ragged chute, Montreal river...34, 139
Ragged chute, South river..... 127
Ragged fall, East river Sheet harbour 210
Ragged lake..... 213
Ragged rapid, Mississippi river..... 143
Ragged rapid, Sable river..... 129
Ragged rapid, Severn river.....34, 124
Railway Act, reference to..... 276
"Railway Belt," B.C.....275, 308
Railway Belt Water Act..... 314
Rainfall records, New Brunswick... 238
Rainy river.....134, 363
Rainy Valley rapid..... 211
Ranney fall, Trent river..... 109
Rapide des Hêtres..... 174
Rapide des Roches..... 189
Rapide Malin..... 181
Rapide Plat, Rouge river..... 169
Rapide Plat, St. Lawrence river.... 107
Rapid fall, Liverpool river..... 217
Rat river..... 189
Rawdon village..... 173
Raymond mill..... 220
Recollet rapid..... 127
Recollet lock..... 146
Reconnaissance survey, N.Brunswick 234
Reconnaissance survey, value of.... 19
Red Deer river.....287, 294
Red Flower fall..... 193
Redman run..... 223
Red rapid 272
Red river, reports on 362
Red Stone rapids..... 268
Renfrew Milling Co..... 142
Renfrew Power Co..... 142
Renous river..... 268

PAGE

Restigouche river.....230, 269
Reversible falls, St. John river.... 241
Reynard fall..... 219
Rheaume fall..... 169
Ribbon river..... 175
Rice's mill dam..... 221
Richelieu river.....165, 186
Richmond..... 185
Rickaby rapid..... 177
Rideau falls..... 145
Rideau river..... 144
Rigaud..... 168
Rigaud river..... 168
Rimouski..... 182
Rimouski river..... 182
Riparian ownership, New Brunswick 233
Rivière aux Outardes..... 161
Rivière du Loup.....157, 172
Rivière du Milieu..... 175
Rivière du Nord Water Power Co... 153
Rivière du Sud..... 183
Robar mill..... 216
Robbin mill-dam..... 270
Roberval electric plant..... 179
Robicheau mill..... 220
Robinson mill-dam..... 270
Rocher Capitaine rapid..... 149
Rocher Fendu rapid..... 148
Rocher rapid, St. Maurice river.... 174
Rockaway fall..... 169
Rock Glen Power Co..... 119
Rock island..... 185
Rock rapid..... 293
Rocky island..... 268
Rocky fall..... 217
Rocky rapids..... 293
Rocky Saugeen river..... 121
Rolling's mills, Musqudoboit river... 209
Romaine river.....161, 190
Roosevelt, President, action taken by, *re* Niagara falls..... 58
Rorke, L. V. on water-powers of New Ontario..... 100
Rosebank..... 144
Roseway river..... 219
Rosseau dam..... 274
Rossland.....318, 319
Rossland Water & Light Co..... 318
Ross mill..... 224
Ross, Sir George, and Western Ont. municipalities..... 41
Ross rapid, Maganetawan river.... 126
Ross river, Yukon..... 288
Rouge river, Ont 111
Rouge river, Que..... 169
Round lake.....212, 215
Round lake dam..... 211
Roxton falls..... 186
Ruisseau Leblanc..... 181
Rupert river.....166, 167, 193
Rush dam..... 211
Russell, H. A. quoted *re* water pollution..... 197
Rutherford dam..... 208
Ruth fall..... 210

PAGE

S

Sabbie river..... 268
Sable falls, Sable river, Ont..... 121
Sable rapids, Ottawa river..... 147
Sable river, Ont.....121, 128
Sable river, P. E. I..... 228
Sable river, Que..... 179
Sackville river..... 213
Sadler mill-dam..... 272
Saguenay river.....159, 178, 189
Saint—*See* St.
Salmon creek, St. Francis river, Que 185
Salmon fall, St. Croix river, N.B.... 264
Salmon fall, Gold river, N.S..... 215
"Salmon House," B.C..... 323
Salmon river, B.C.....319, 323
Salmon River fall..... 211
Salmon river, N.B.....241, 267
Salmon river (Colchester Co.) N.S... 212
Salmon river (Digby Co.) N.S..... 220
Salmon river (Halifax Co.) N.S..... 211
Salmon river, Que..... 186
Salmon river (Yarmouth Co.) N.S.. 220
Salter fall..... 217
Sam Morgan mill site..... 222
Sanders dam..... 223
Sanderson rapids..... 169
Sandhill portage..... 131
Sandy fall, Mattagami river.....34, 137
Sandy fall, Sturgeon river..... 127
Sandy lake..... 214
Saskatchewan, stream flow in..... 289
Saskatchewan, water-powers of....
.....22a, 275, 285, 292
Saskatchewan river (North branch)
.....286, 287
Saskatchewan river (South branch) 292
Saskatoon..... 292
Sauder, P.M., report of, referred to. 285
Saugeen Light & Power Co..... 34, 120
Saugeen river..... 120
Saulnier fall..... 220
Saulnier mill..... 220
Sault-au-Cochon river..... 180
Saunby dam..... 117
Saunders dam..... 268
Savanne fall..... 189
Sawler lake..... 215
Sawyerville..... 185
Scadouac river..... 267
Schooner Passage fall..... 221
Schreiber..... 132
Scotsman rip, Nictaux river..... 223
Scotstown..... 186
Scugog river..... 111
Seaforth..... 50
Seal river..... 228
Second lake..... 208
Seguin river..... 126
Seine fall..... 134
Seine river..... 134
Sepewesk lake, rapid above..... 289
Serpent river..... 129
Serpentine river..... 273

PAGE
Seton lake..... 322
Seven-league lake..... 149
Seven-mile lake..... 202
Seven-mile stream..... 210
Seven Sisters rapid..... 124
Severn river..... 124
Sevogle river..... 268
Sextant rapids..... 138
Seymour Power & Electric Co..... 109
Shabogama lake..... 193
Sharpe mill-dam..... 270
Sharp-rock fall..... 137
Shawinigan falls.....174, 175
Shawinigan river..... 175
Shawinigan Water and Power Co... 153
Shediac Electric Light & Power Co.. 267
Sheep rips, Bear river..... 221
Sheep river, Alta..... 286, 290
Shehea lake..... 213
Shelburne, N.S., municipal plant... 219
Shelburne, N.S..... 203
Shelburne, Ont..... 123
Shell river..... 291
Sherbrooke..... 185
Sherbrooke Power & Ry. Co..... 185
Sherbrooke Water-power Co..... 152
Sherwood dam..... 272
Sheet Harbour lake..... 210
Shiktahawk river.....241, 272
Shikwamkwa river..... 131
Shingle fall..... 213
Ship Harbour lakes..... 209
Shipshaw river.....178, 189
Shogomoc river..... 271
Shubenacadie Grand lake..... 208
Shubenacadie river.....208, 226
Siffleur lake..... 323
Silver creek..... 122
Silver fall, Little river, N.B..... 267
Silver fall, Winnipeg river, Man..... 291
Simcoe, Ont..... 116
Simcoe Ry. & Power Co.....34, 124
Similkameen river..... 320
Simpson river..... 319
Simpson stretch, Steel river..... 132
Singhampton..... 123
"Sink Spout"..... 216
Sissibou fall, Weymouth river..... 221
Sissibou river..... 227
Sisson branch, Odell river..... 273
Sisson falls, Odell river..... 273
"Six Portages" rapid, Gatineau
river..... 170
Skeena river.....317, 323
Skinner Company..... 107
Slate fall, Madawaska river..... 142
Slate fall, Mississippi river..... 129
Slaugenwhite mill..... 214
Slave fall, Winnipeg river.....285, 291
Slocan lake.....202, 210
Slocan river..... 320
Sluice fall..... 272
Smith creek..... 142
Smiths Falls..... 145
Smiths Falls Electric Co..... 145

PAGE

Smith river. 270
Smoky fall, Sturgeon river. 127
Smoky Hill fall. 193
Smoky river, Alta. 287
Smooth-rock fall. 137
Snake fall. 171
Snake Lake dam 214
Snake rapid. 142
Snider, E. W. B. 38
Snye E. dam. 126
Soldier lake. 208
Somerville. 177
Soper creek. 111
Sorcier branch, river du Loup. 172
Sorrow fall. 219
Soulanges canal. 187
Southampton. 120
Southern Alberta Land Co. 296
Southeastern New Brunswick. 267
Southgate river. 323
South Kootenay Water Power Co. . . 318
South lake. 214
South Branch falls, Oromocto river . 270
South Fork river. 287, 294
South river. 127
South River station. 127
South Saskatchewan river. 292
Southwestern New Brunswick. 264
Spanish chute. 128
Spanish river. 127
Spanish River Pulp & Paper Co. 127
Speed river. 116
Spedic falls. 265
Spence dam. 224
Spillimacheen river. 319
Split-rock rapid. 132
Split-rock fall. 220
Sprague fall. 264
Springbank. 117
Spring Bridge river. 218
Spring creek. 117
Sproat lake. 322
Squamish river. 323
Squaw chute. 129
"Square Forks". 268
Ste Adèle. 169
St. André-de-l'Epouvante. 179
St. Andrews. 168
St. Ange rapid. 189
St. Ann, North river. 225
Ste. Anne river. 158
Ste. Anne-de-Beaupré river. 176
Ste. Anne-de-la-Pérade. 177
Ste. Anne-de-la-Pérade river. 177
Ste. Brigitte-des-Saults. 184
St. Catharines. 113
St. Césaire. 186
St. Clair lake, tributaries of. 115, 118
St. Croix Paper Co. 264
St. Croix river, N.B. . . 230, 256, 264, 265
St. Croix river, N.S. 224
St. Damien. 172
St. David d'Yamaska. 186
St. Didace. 172
St. Elie de Caxton. 172

PAGE

St. Félicien bridge. 189
St. Féréol falls. 176
St. Francis river, N.B. 274
St. Francis river, N.B., daily guage elevations. 248
St. Francis river, N.B., discharge measurements of. 247
St. Francis river, Quebec. 165, 184
St. Gabriel. 176
St. Gabriel locks, (Lachine canal). . . 188
St. George, (Beauce Co.). 183
St. George fall. 265
St. Jean-de-Matha. 173
St. Jérôme. 169
St. Joachim fall. 176
St. John, N.B. 267
St. John lake, Que. 179
St. John Lumber Co. 235
St. John river, N.B. and Me. 270
St. John river, N. B., daily gauge elevation. 244, 249
St. John river, N. B., daily gauge height. 257
St. John river, N.B. and Me., description of. 240
St. John river, N.B., discharge data and curves, explanation of. 242
St. John river, N.B., discharge measurements above Allagash. 243
St. John river, N.B. and Me., International Commission. 235
St. John river, N.B. *re* power sites. . . 241
St. John river, N.B. rating table, Grand Falls. 261
St. John river, N.B., reversible falls. . . 241
St. John river, N.B. and Me., run-off 250
St. John river, N.B., and Me., tributaries of. 270
St. John river, N.B., water levels. . . 242
St. John river, Que. 190
St. Johns Quebec. 187
St. Joseph d'Alma. 178
St. Joseph rapid. 170
St. Jovite. 169
St. Lawrence canals. 106
St. Lawrence Power Co. 106
St. Lawrence river. 10, 107, 163, 187, 363
St. Lawrence river and tributaries. . 106
St. Lawrence River Power Co., Massena, N.Y. 107
St. Lawrence Steel & Wire Co. 107
St. Louis river. 187
Ste. Marguerite river. 180, 190
Ste. Martine. 187
St. Mary rapid. 130
St. Mary river, Alta. 286, 290, 294
St. Mary river, B.C. 320
St. Mary river, N.S. 212, 226
St. Mary river, Ont. 130, 363
St. Mary river, Ont., U.S. federal act *re* water rights on 7
St. Marys. 50, 118
St. Maurice river. 158, 174
St. Narcisse. 177
St. Ola. 109

	PAGE
St. Ours	186
St. Paul fall	137
St. Peter fall	137
St. Raymond	177
St. Thomas	50
St. Timothée	187
Ste. Ursule fall	172
St. Williams	117
Standard schedule for light and power in Western Ont	51
Standoff, Alta	290
Stanley	270
Stanstead	185
Star City	292
Star Company	208
Statistical tables, explanation of	104
Stave Bridge rips, Bear river, N.S.	221
Stave Falls power plant	317
Stave lake, B.C.	317
Stave river, B.C.	317
Stephens rapid	109
Stewiacke river	212
Steel river	132
Steep-rock fall	134
Stikine river	324
Stillwater bridge, St. Mary river	212
Stoke Centre	185
Stony rapids	293
Stony Portage fall	131
Stratford	50
Strathcona, Ont	108
Streetsville	112
Stuart lake	322
Sturgeon fall, Gatineau river	171
Sturgeon fall, Mattagami river	137
Sturgeon fall, Seine river	134
Sturgeon fall, Sturgeon river	127
Sturgeon fall, Winnipeg river	291
Sturgeon river, Alta	293
Sturgeon river, Ont	127
Sturgeon river, P.E.I.	228
Sudbury, Ont	127
Sudbury Power Co	128
Sud, rivière du	163
Summit lake	322
Sunday lake	184
Superior lake, tributaries of	126
Sydenham river	122
Sylvan valley	130

T

	PAGE
Table fall	169
Tacla lake	322
Takhini river	288
Taku river	324
Talking fall, Eastmain river	193
Talon chute	140
Tangier lake	210
Tangier river	210
Taxes river	268
Tay river	145
Tcharkamisht river	323
Teeswater river	120
Teeterville	117
Temperance Vale mill-dam	271
Ten-mile dam	210
Terrace Mountain rapid	192
Terrebonne	146
Teslin river	288, 317
Tetagouche fall	231
Tetagouche river	231, 269
"Tête Jaune Cache"	320
Thames Cereal Co	118
Thames river	117
"The Fishery" (near Ivy)	123
"The Ledges," St. John river	274
"The Notch," Montreal river	34
Thibaudeau W	19, 283, 285
Third chute, Bonnechère river	141
Third Stillwater fall, Liverpool river	218
Thomas lake	208
Thomas mill site	221
Thompson, B.C.	326
Thompson rapid	292
Thompson River valley	295, 321, 326
Thornbury, Ont	122
Thorold, Ont	114
Threemile lake	124
Three Rivers, Que	177
Tib creek	287, 294
Tignish river	228
Tillsonburg	50, 117
Timber driving companies in Quebec, rights of	152
Timiskaming lake	149
Tobin rapids	286
Toby river	319
Tobique river	241, 272
Tochieca river	324
Todd dam	264
Tomifobia river	185
Tom King rapids	137
Tom Tidney river	218
Toronto and Niagara Power Co	80
Toronto Board of Trade	36
Toronto Bolt and Forge Co	107
Toronto city council, action taken *re* power	35, 36, 39
Toronto Paper Mfg. Co	106
Toronto Power Co	79, 80, 81
Toronto, power prices in	50
Tottenham	123
Tottenham brook	123
Tourists and inland waters of N.S.	200
Tracey	270
Trail, B.C.	318, 319
Transmission lines, Ont	50
Travers lake	141
Traverston	121
Trembling Mountain lake	169
Trenton Electric and Water Co	109
Trenton Junction	109
Trent river	109, 110
Trent River Paper Co	109
Trent valley water-powers	54
Trout creek, Alta	290
Trout creek, Middlesex Co., Ont	118
Trout creek, Parry Sound, Ont	127

PAGE

Trout river, P.E.I. 228
Truax dam 120
Truro, N.S. 212
Tryon river, P.E.I. 228
Tsacha lake 322
Tusket river 219, 220
Tweed 108
Twin falls, Moon river 124

U

Ufford 124
Underground waters 4
Ungava 282
Union dam 210
Union of Canadian Municipalities 35, 37, 43, 371
Upsalquitch river 269
Upper Burnt chute 126
Upper fall, Kawaskagama river 136
Uxbridge 123

V

Valleyfield 187
Vanceboro 265
Vanceboro storage dam 265
Vancouver Island 322
Vancouver Island watersheds 314
Vancouver Power Co 317
Vancouver, power developments near 317
Veinot 216
Vermilion fall, Peace river 287, 293
Vermilion river, Ont 128
Vermilion river, Que 175
Victoria, B. C., power developments near 318
Victoria lake dam 266
Victoria Mines 128
Victoria rapid 132
Vienna 117
Village des Aulnaies 183
Vinegar lake 215
Virgin fall 132

W

Wabageshik chute 128
Wabageshik falls, Vermilion river 34
Wabageshik rapid 128
Wabi river 34, 139
Wabigoon river 135
Wabinosh river 132
Waddington cañon 323
Wagner ledge 221
Waha, White Lake creek 142
Walker chute, Rouge river 169
Walker dam, Caraquet river 269
Walkerton 120
Wallace river 224
Wambott fall 223
Wanapitei Power Co. 34, 127
Wanapitei river 127

PAGE

Waneta, B.C. 320
Wapiti river 287
Warren creek 119
Washikuti river 190
Water Act, British Columbia 303
Water Clauses Consolidation Act, British Columbia 311
Water diversion, regulations *re*, in Nova Scotia 200
Waterford 116
Water levels, St. John river 242
Waterloo 50, 116
Water-power districts, British Columbia 316
Water-power lease, Ontario, form of 29
Water-power leases, Ont. 34
Water-power license, terms of, Man., Sask. and Alta. 279
Water-powers of Alberta 275, 285
Water-powers of British Columbia 303
Water-powers of Canada 1, 22a
Water-powers, Dominion Lands 275
Water-powers of Manitoba 275, 283
Water-powers of New Brunswick 230, 264
Water-powers of Northwest Territories 275
Water-powers of Nova Scotia 195, 208
Water-powers of Ontario 23, 100, 106
Water-powers of Quebec 150, 154, 168
Water-powers in Railway Belt and Peace River Block 310
Water-powers of Saskatchewan 275, 285
Water-powers of Yukon 275, 288
Water-powers, value of reconnaissance surveys 19
Water reservoirs, natural 18
Waterton lake 294
Waters, bibliography of law of 372
Waterton mills 290
Waterton river 287, 290
Waterville 185
Waterville mill 271
Waterways, effect of factory pollution 9
Waterways, reports on 365, 367
Waverley Lake district, N.S. 208
Wawatian fall 137
Webber lake 213
Webster-Ashburton treaty, reference to 235
Weir fall 219
Welch mill site 221
Welland 114
Welland canal 62, 69, 113
Welland Vale Mfg. Co 113
Wellesley 115
Wentzel lake 216
Westbury 185
Western Canada, irrigation in 295
Western Canada Power Co 317
Western Ontario Municipal Niagara Power Union 35
Western Power and Light Co. 291
West Kootenay Power and Light Co. 318
West lake 216

PAGE

West river.... 228
West river Sheet Harbour.... 210
Westmorland river.... 228
West Northfield.... 216
Weston.... 50, 112
Westport.... 144
Westport Electric Light & Mfg. Co.. 144
Weymontachi rapid.... 174
Weymouth.... 227
Weymouth river.... 221
Wheatley river.... 228
Wheelock fall.... 216
Whiskey lake.... 129
White chute, Nipigon river.... 132
White fall, Blind river.... 129
White fall, Little Peribonka river... 189
White fall, Metabetchouan river.... 179
White fall, White river.... 130
Whitefish falls.... 128
Whitefish river, Ont.... 128
Whitefish river, Que.... 193
White Lake creek.... 142
Whiteman creek.... 115
White mill.... 271
White river, B.C.... 319
White river, Ont.... 130, 131
White rock.... 227
White Rock dam.... 223
Whitemud fall.... 289, 291
White Otter fall.... 131
White Pine Lumber Co.... 129
Whitman and Barnes, Messrs.... 113
Wiarton.... 121
Williamstown Lake dam.... 271
Willie fall.... 189
Willis, Bailey.... 3
Wilson dam.... 178
Wilson, James.... 114
Wilson & Mitchell, Messrs.... 107
Windigo lake.... 139
Windsor mills.... 184
Windsor river.... 185
Wingham.... 119
Winnipeg Electric Ry. plant.... 291
Winnipeg municipal electric plant.... 285, 291
Winnipeg river 34, 134, 283, 284, 291
Winnipeg Street Railway Co.... 285
Winter river.... 228
Wolf river.... 133
Wolfram fall.... 125
Wood river.... 319
Woods, lake of the.... 284
Wolverton.... 115
Woodstock Electric Co., N.B.... 271
Woodstock Electric Co., Ont.... 50
Wright lake.... 214
Wright mill.... 214
Wright river.... 130
Wroxeter.... 119
Wyman mill.... 220

Y

Yamachiche river.... 172
Yamaska river.... 186
Yarker, Ont.... 108
Yarmouth county, N.S.... 204
Yellow fall.... 137
Yellowhead pass.... 320
York.... 115
York river.... 142
York woolen mill dam.... 266
Young, W. C.... 34
Youngs point.... 110
Yukon Gold Co.... 288
Yukon river.... 288, 317
Yukon, water-powers of..22a, 288, 275

Z

Zwicher.... 216